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The State and The Exp. Station

8 May, 1893 – 4 Jun., 1896

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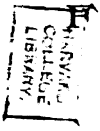
STATE OF CONNECTICUT.

ANNUAL REPORT

—OF—

The Connecticut Agricultural Experiment Station

For 1892



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The State.

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OFFICERS AND STAFF FOR 1892.

STATE BOARD OF CONTROL.

Ex-officio.

His Exc. MORGAN G. BULKELEY, *President.*

Appointed by Connecticut State Agricultural Society:	Term expires.
Hon. E. H. HYDE, Stafford, *Vice-President.*	July 1, 1894.
Appointed by Board of Trustees of Wesleyan University:	
Prof. W. O. ATWATER, Middletown.	1894.
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1895.
H. L. DUDLEY, New London.	1893.

EXECUTIVE COMMITTEE.

Appointed by Board of Agriculture:	
T. S. GOLD, West Cornwall.	1895.
Appointed by Governing Board of Sheffield Scientific School:	
W. H. BREWER, New Haven, *Secretary and Treas.*	1893.
Ex-officio.	
S. W. JOHNSON, New Haven, *Director.*	

Chemists.

E. H. JENKINS, Ph.D., *Vice-Director.*
A. L. WINTON, Ph.B.
T. B. OSBORNE, Ph.D.
A. W. OGDEN, Ph.B.
CLARK VOORHEES, Ph.B.*
WORTHINGTON SMITH, B.A.†

Mycologist.

WILLIAM C. STURGIS, Ph.D.

Stenographer and Clerk.

Miss F. M. BIGELOW.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helper.

HUGO LANGE.

* Till Oct. 1st. † From Oct. 1st.

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ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, useful or injurious insects, moulds, blights, mildews, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station makes analyses of Fertilizers, Seed-Tests, etc., etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.
2. That the samples are taken from stock now in the market, and in accordance with the Station instructions for sampling.
3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs and like Associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the use of individuals will be charged for at moderate rates. The Station will undertake no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of general interest will be published in the Bulletins, of which copies are sent to each Post Office in this State, and to every citizen of the State who applies for them. These results will be summed up in the Annual Reports made to the Governor.

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It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention should be *prepaid*, and all communications should be directed, *not to any individual officer*, but simply to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

☞ Station Grounds, Laboratories and Office are on Suburban st., between Whitney avenue and Prospect st., 1¼ miles North of City Hall. Suburban st. may be reached by Whitney ave. Horse Cars, which leave the corner of Chapel and Church sts. four times hourly, viz: on the striking of the clock and at intervals of fifteen minutes thereafter.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 118 Court st., or from Peck & Bishop's Office in Union R. R. Depot.

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Company, "For the purpose of conducting and carrying on the business of an experiment in the culture and cure of tobacco, the same to be conducted and carried on in connection with and under the supervision of the Conn. Agricultural Experiment Station. The place where the said business is to be carried on is Poquonock, in the town Windsor," Conn.

The stockholders elected the following officers:—President, S. O. Griswold; Vice-President, Eugene Brown; Secretary, E. S. Hough; Treasurer, L. R. Lord; Board of Management, H. H. Ellsworth, Eugene Brown, J. A. DuBon, H. W. Alford, J. G. Thrall, A. E. Holcomb and R. D. Case. An executive committee was also chosen consisting of H. H. Ellsworth, H. W. Alford and J. A. DuBon, to whom was committed the practical management of the experiment itself.

A stock subscription book was opened and the Company was soon able, from the proceeds of stock sales, to purchase one and one-half acres of land, judged to be perfectly adapted to its purposes, and to arrange for the building of a barn large enough to hold the crop of two acres of tobacco. The land was at once cleared and prepared for planting.

The company's committee and the representatives of this Station after full discussion agreed upon this

General Plan of Experiment.

1. The following experiments should be carried out on the same land for at least five years in succession.

2. While the quantity of crop should be accurately determined, very special attention should be given to the judgment of its quality for cigar wrappers. This judgment should be given by men of large practical experience in the trade in leaf tobacco, and the samples should be so submitted that the judges should have no knowledge of any particulars regarding the manner in which the separate lots of leaf were raised.

3. The final judgment on its quality should be made after the leaf has been fermented in the usual way, and the whole crop rather than small samples from each crop should be fermented together.

4. The following questions are those which, as far as circumstances permit, should receive immediate attention:

a. What is the effect on quantity and quality of leaf of larger applications of cotton seed meal than are commonly used as a fertilizer?

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b. What is the comparative effect on quantity and quality of leaf, of applications of castor pomace containing the same amounts of nitrogen as the cotton seed meal used in experiments under *a*?

c. If a heavy application of nitrogen in form of castor pomace proves injurious to the leaf, can the injury be lessened or prevented if a half of this quantity of nitrogen is supplied by castor pomace and the other half by nitrate of soda?

d. What are the comparative effects on quality and quantity of leaf of applications of equal quantities of potash in the following forms: Cotton hull ashes, high grade sulphate of potash, the same with lime, double sulphate of potash and magnesia, the same with lime, pure carbonate of potash, and pure nitrate of potash?

e. Is it possible to absolutely prevent "pole-burn" and to cure the crop perfectly on the stalk, by the use, in very damp "muggy" weather, of artificial heat simply as a means of ventilating and partly drying the air of the barns?

The company's committee requested the Station to plan the construction of the barn and the arrangement of the experiment, to take the general charge of it, to make and record all weights and to preserve and publish the results with suitable discussion of them.

The committee were fortunate to secure the services of Mr. John A. DuBon who planted, cultivated, harvested, cured and sorted the crop in coöperation with the Station.

Mr. DuBon did all this in the most thorough and efficient way and the success which has been attained this year in spite of the late organization of the company and the consequent hurry at planting time is largely due to his untiring work and careful attention to all the vexatious details incident to a somewhat extensive and carefully executed experiment; details which can only be fully understood by one who has had experience with them.

The Experiment Field.

The soil of this field is like much of the upland tobacco soil of the Connecticut valley and may be described as a very fine light sandy loam. Its chemical and mechanical examination will be noticed in another place.

For five or six years the field had scarcely been fertilized or cultivated at all and tobacco had not been raised there for a very long term of years. When bought it was covered with a neg-

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lected growth of "poverty grass" (*Andropogon scoparius*), blackberry vines, and wild growth of various sorts. After careful plowing and harrowing, the field was measured by the Station into twenty-three plots, each of them 27 feet wide and 80½ feet long, containing 2173½ square feet or 4½ square feet less than one twentieth of an acre. The plots were separated by a space 3½ feet wide and their boundaries were marked by stout chestnut posts.

Fertilizers.

The fertilizers were all sampled and analyzed by the Station. The raw materials used contained the following percentages of nitrogen, phosphoric acid and potash.

	Nitrogen.	Available Phosphoric Acid.	Potash.
Nitrate of Soda	15.9	....	....
Nitrate of Potash	13.8	....	44.9
Cotton Seed Meal	7.0	3.0	1.8
Castor Pomace	5.3	1.7	1.0
Cooper's Bone Dust	1.6	29.2	....
Cotton Hull Ashes	....	7.0	20.9
High Grade Sulphate of Potash	....	....	50.6
Double Sulphate of Potash and Magnesia	....	....	25.7
Carbonate of Potash	....	....	54.1

The quantities of chemicals for each plot were accurately weighed by the Station representative, mixed thoroughly under his supervision, bagged and labeled in such a way as to give no clue to any other person as to the contents of the bags or as to the plots for which they were intended.

The bags were carried to the several plots under his direction and their contents were sowed on the plots in his presence.

Certain manufacturers of tobacco manures subscribed to the stock of the company and requested that their manures as submitted by them might also be included in the experiment, subject to the same treatment as the other plots. The following persons and companies thus joined in the experiment: H. J. Baker & Bro., N. Y., Bowker Fertilizer Co., Boston, F. Ellsworth, Hartford, Mapes' Formula & Peruvian Guano Co., N. Y., L. Sanderson, New Haven.

The mixed fertilizers supplied by these manufacturers were also weighed, sampled and analyzed by the Station with the following results:

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ANALYSES OF MIXED FERTILIZERS.

	Baker's Tobacco Manure.	Baker's AA Phosphate.	Stockbridge Tobacco Manure.	Bowker's Fertilizer.	Ellsworth's Starter.	Ellsworth's Foundation.	Mapes' Tobacco Manure W. B. Normal.	Mapes' Tobacco Manure W. B. with extra Potash.	Mapes' Tobacco Manure W. B. with extra Potash and Phosphoric Acid.	Mapes' Starter.			Sanderson's Formula B.
	Plot Q	Plot Q	Plot R	Plot S	Plot T	Plot T	Plot U	Plot V	Plot W	Plot U	Plot V	Plot W	Plot X
Nitrogen as Nitrates	---	.34	1.65	2.72	7.38	----	1.53	1.42	2.19	.28	.25	.28	1.28
" as Ammonia	3.05	.96	----	----	----	----	3.23	2.86	2.58	.51	.51	.51	1.95
" Organic	1.34	1.57	3.31	2.75	1.11	5.12	1.34	1.69	----	2.14	2.11	2.08	2.45
TOTAL NITROGEN	**4.39**	**2.87**	**4.96**	**5.47**	**8.49**	**5.12**	**6.10**	**5.97**	**6.21**	**2.93**	**2.87**	**2.87**	**5.68**
Soluble Phosphoric Acid	4.61	9.01	trace	trace	4.72	trace	trace	trace	trace	7.58	7.55	7.62	3.58
Reverted " "	1.06	2.86	4.08	2.95	2.41	4.52	3.97	3.63	4.00	3.77	3.77	3.46	5.12
Insoluble " "	trace	.22	6.26	4.00	.89	1.79	2.34	1.74	2.19	1.83	1.69	1.87	.86
TOTAL PHOSPHORIC ACID	**5.76**	**12.09**	**10.34**	**6.95**	**8.02**	**6.31**	**6.31**	**5.37**	**6.19**	**13.18**	**13.01**	**12.95**	**9.56**
Potash as Muriate	.89	2.60	1.53	2.44	----	----	1.20	1.47	.98	.70	.67	.53	.28
" as Sulphate	10.79	----	4.77	7.33	2.86	5.26	10.11	13.92	12.32	2.69	2.69	2.97	10.29
TOTAL POTASH	**11.68**	**2.60**	**6.30**	**9.77**	**2.86**	**5.26**	**11.31**	**15.39**	**13.30**	**3.39**	**3.36**	**3.50**	**10.57**
Chlorine	.67	3.18	1.15	1.83	trace	trace	.90	1.10	.74	.53	.50	.40	.21

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These mixtures differ in some cases from the regular brands put on the market by the manufacturers. *The object is not by any means to make a competitive test of the regular brands of tobacco manures,* but rather to test the value of certain mixtures in order to afterwards alter the composition of the regular brands if the results of these trials shall make it seem advisable.

All the fertilizers were very carefully and evenly sown when no wind was blowing, under the personal direction of Mr. DuBon and the Station representative. The plots were immediately harrowed by Mr. DuBon, each by itself to avoid carrying fertilizer from one plot to the next. The whole piece was then "rowed out" in the usual way, the rows running east and west.

The following statement shows what fertilizers were put on each plot, their cost and the quantities of nitrogen, phosphoric acid and potash contained in them, *expressed in pounds per acre.*

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains Pounds		
			Nitrogen.	Phosphoric Acid.	Potash.
A	1500 Cotton Seed Meal 1500 Cotton Hull Ashes	$50.20	105	150	341
B	2000 Cotton Seed Meal 1500 Cotton Hull Ashes	57.25	140	165	350
C	2500 Cotton Seed Meal 1500 Cotton Hull Ashes	63.75	175	180	359
D	3000 Cotton Seed Meal 1500 Cotton Hull Ashes	70.50	210	195	368
E	1980 Castor Pomace 1500 Cotton Hull Ashes	50.79	105	139	334
F	2640 Castor Pomace 1500 Cotton Hull Ashes	57.72	140	150	340
G	3300 Castor Pomace 1500 Cotton Hull Ashes	64.65	175	161	347
H	4000 Castor Pomace 1500 Cotton Hull Ashes	72.00	212	173	354
	2640 Castor Pomace 1500 Cotton Hull Ashes 220 Nitrate Soda* 220 " " †	68.72	210	150	340

* Applied between rows at time of first cultivation.

† Applied between rows at time of second cultivation.

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Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains Pounds		
			Nitrogen.	Phosphoric Acid.	Potash.
J	2640 Castor Pomace 1500 Cotton Hull Ashes 440 Nitrate Soda†	$68.72	210	150	340
K	1500 Cotton Seed Meal 1220 Double Manure Salt 360 Cooper's Bone	43.95	110	150	341
L	1500 Cotton Seed Meal 1220 Double Manure Salt 360 Cooper's Bone and 300 Lime	44.70	110	150	341
M	1500 Cotton Seed Meal 620 High Grade Sulphate of Potash 360 Cooper's Bone	42.70	110	150	341
N	1500 Cotton Seed Meal 620 High Grade Sulphate of Potash 360 Cooper's Bone and 300 Lime	43.45	110	150	341
O	1500 Cotton Seed Meal 580 Carbonate of Potash 360 Cooper's Bone	74.95*	110	150	341
P	760 Nitrate of Potash 500 Cooper's Bone	66.47*	110	146	341
Q	2020 Baker's A. A. Superphosphate 3920 " Tobacco Manure	....	230	466	510
R	2000 Stockbridge Tobacco Manure	....	99	207	126
S	4000 Bowker's Tobacco Fertilizer	....	219	278	391
T	900 Ellsworth's "Starter" 2700 " "Foundation"	....	215	238	168
U	501 Lime 501 Mapes' Starter 2601 " Tobacco Manure W. B.	....	173	230	312
V	501 Lime 501 Mapes' Starter 2601 " Tobacco Manure Special	....	170	205	418
W	501 Lime 501 Mapes' Starter 2601 " Tobacco Manure Special	....	176	227	364
X	6080 Sanderson's Formula B.	....	345	581	643

* If bought in ton lots not chemically pure the cost would be considerably less.

† Applied between rows at time of first cultivation.

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The Plants and Planting.

The plants were from seed raised by Mr. DuBon in 1890, of the so-called "Havana seed." It may be said for the benefit of those unfamiliar with the local meaning of this term, that it has been a practice to obtain seed from the island of Cuba, plant it in Connecticut and raise seed year after year from it. The plants in the first years are too small to suit the demands of our market but they increase in size and after the first four generations of plantings the size becomes satisfactory and seed saved in one year may be used for the planting of the next six to ten years. Seed so obtained is called "Havana" or "Conn. Havana" seed. The special variety, used by Mr. DuBon for the last ten years, is called the "Hubbard." He has generally raised the seed each year, though at two different times he has used one year's seed for the three next years' planting.

The rows were three feet and a half apart, eight rows in a plot, and the plants were accurately set seventeen inches apart, making about 8700 to the acre.

The plants were set out by Mr. DuBon and his men on June 8th.

Notes during the Growing Season.

Following is Mr. DuBon's record kept during the months that the crop was growing:

June 8.—Planted the whole piece to-day.

June 9.—Very heavy rain covering many of the plants with earth.

June 11.—Cut worms are destroying many of the plants. Reset 2500 plants.

June 20.—Plots D, G and L very slow to start growing. Some plants on them appear to be dying as if scorched by the fertilizer. Plots A, H, K, N start best of all. R and S next. U and V next.

July 2.—Plot P is the smallest of all; color yellowish green. D and G are a little backward.

July 3.—1000 more plants reset.

July 5.—11 pounds nitrate of soda applied on plot I, and 22 pounds on plot J.

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July 10.—Tobacco on plot P is still very small. Color yellowish green, but is growing darker. Tobacco on O is also very small. That on Q is the largest of all. The tobacco on B, C, D, F, G, H is very uneven on account of the attack of cut-worms.

July 17.—Tobacco on P is still smallest of all and O comes next. Color of both pale green. Tobacco on Q is largest of all and very dark green. R and S have the next largest tobacco and of good color.

July 25.—Applied 11 pounds of nitrate of soda to plot I. Tobacco on Q very much larger than on other plots. P still the smallest and light in color.

July 26.—Commenced topping. Tobacco on Q was nearly all topped at first topping. On P only a few plants topped. On O one-tenth of the plants topped. On H and L one-fourth of them topped. On N and T four-fifths of them topped. I and J are improving very fast. The weather is very dry, but on those two plots the tobacco looks as if it had all the moisture it needed, while the rest of the piece is somewhat parched.

July 31.—A nice, quiet rain has fallen.

Aug. 6.—Finished topping.

Aug. 23.—Tobacco on P is still the smallest. Color light green. That on B is next smallest, O comes next. The tobacco on Q is the largest of all, H next largest, then J, then I, and then S. All are ripe except P. O has not improved in the last ten days.

Aug. 29.—Commenced cutting and cut fourteen plots.

Aug. 30.—The remaining nine plots were cut and all the crop was hung up to pole-cure. Most of the crops were slightly overripe except P, which is still somewhat green. The quality of tobacco on plots A, E, M and N has been injured by its getting over ripe. It has lost somewhat its elasticity, "life." This should be borne in mind in judging of its quality.

Harvest and Curing.

The delay in cutting was due to the delay of workmen in finishing the fittings of the curing barn.

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Representatives of the Station were present at the cutting and each lath on which the stalks were strung was marked with the number of the plot, the total number of laths from each plot was noted, and all the tobacco from each plot was hung together in the barn. There were three "bents" for hanging tobacco, one over another, and a third of the tobacco from each plot was hung on each of these, so that there should be no difference in the exposure of the tobacco of different plots. The barn was kept securely locked during the curing time.

It should be said for the information of those unfamiliar with the process of tobacco curing in this State, that the leaves are cured on the stalk, whole plants being cut and strung on laths (six or seven stalks to a lath), by piercing the stalk near the butt with a "spear" which is slipped on the end of the lath. The laths rest by their ends on the bents in the barn and the stalks hang tip downwards.

The barn was fitted with furnaces to supply artificial heat in case pole-burn was feared; but the weather was so favorable for curing that they were not used.

On November 15 during a favorable "tobacco storm," all of the tobacco was taken down on the laths, and on November 16 and 17 the tobacco was stripped from the stalks and bundled. It was labeled and weighed by the Station representative and hauled to Mr. DuBon's sorting house.

The stalks from each plot will be cut small and returned to the plots from which they came.

As the tobacco was taken off the laths the latter were recounted and their number in each case tallied exactly with the number noted at cutting time.

Sorting.

The sorting was done by Mr. DuBon and a skilled laborer under his supervision. The representative of the Station was present during the whole time and made and recorded all weights.

The yield of each plot was sorted into long wrappers, short wrappers, top leaves and seconds.

The sorting began in the afternoon of November 28 and was finished at noon on December 6.

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Sampling and Casing.

On the afternoon of December 6 the sorted tobacco was teamed to the public warehouse of Mr. L. B. Haas, 150 State street, Hartford. On the 7th it was sampled and its quality examined by Mr. Haas and Mr. James McCormick. Mr. Haas has been for many years a dealer in leaf tobacco and is believed to be one of the best judges of leaf tobacco in the country. Mr. McCormick has also had a very wide experience in judging of tobacco crops.

On the 7th and 8th of December the tobacco was cased down under Mr. Haas' and Mr. McCormick's direction for fermentation, in the presence of the Station representative. The cases, measuring three feet each way, were lined on bottom, sides and top with either seconds or top leaves so that the wrappers should all receive the full "sweat." The wrappers of different plots were separated by strings and marked with labels so that they can certainly be identified when the cases are opened.

The contents and weights of the cases are here recorded:

Mark.	Wrappers from plots marked.	Lined with	Gross.	Tare.	Net.
Case No. 1.....	19–20–21	103 lbs. top leaves	393	93	300
" 2.....	22–23–14	97 " "	383	86	297
" 3.....	6–15–16	82 " "	386	86	300
" 4.....	17–18–2–13	95 " seconds	384	86	298
" 5.....	10–11–12–3	98 " "	386	86	300
" 6.....	4–3a–9–8	111 " "	399	86	313
" 7.....	7–1–5	114 " "	399	85	314
					2122

The crops from the different plots are designated by numbers and it is believed that only two persons understand to which particular plots these numbers refer.

The Tabulated Results.

The following tables present in detail all the data which have been gathered to assist in forming a judgment of the character of the crop and are followed by explanations and discussion of these data. *It must, however, be always borne in mind that no final judgment can be given as to the relative merits of these crops till they have been fermented and are ready to be rolled into cigars and put on the market.*

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WEIGHTS OF THE BARN CURED LEAVES FROM $\frac{1}{10}$ ACRE.

Plot.	Gross Weight of Leaves.	Weight after Sorting. Long Wrappers.	Short Wrappers.	Top Leaves.	Seconds.	Waste and Shrinkage.	Net Weight of Sorted Tobacco.
A	90	38½	17½	12½	18	3½	86½
B	87½	35½	20½	11½	16	3½	83½
C	95	42½	17	12½	18½	4½	90½
D	99	54½	15	8½	16	5½	93½
E	96½	36½	18½	19½	19	2½	93¼
F	97	38	21	14½	17½	5½	91½
G	93½	44½	13½	10½	18½	5½	88
H	106½	55½	16½	10½	18	6½	100½
I	107½	53	19½	12½	17	5½	101½
J	116	64	17	11½	18	5½	110½
K	100½	47½	20½	10	18½	3½	96½
L	94½	48½	22½	6½	14½	3	91½
M	96	41½	17½	13½	19½	3½	92½
N	88½	37½	15½	12½	20½	3½	85½
O	85	31½	12½	17½	19	5	80
P	67	15½	7	15	24½	4½	62½
Q	119½	63½	22½	13½	14	5½	114
R	91	36½	18½	14½	18	3½	87½
S	108	56	20½	12	14	5½	102½
T	113½	58½	16½	14½	20½	3½	110
U*	119	64½	19½	9½	19½	5½	113½
V*	93½	44½	14½	11½	18½	4½	89
W*	98½	43½	14½	13½	21½	5	93½
X	95½	48½	16½	11	15½	4½	91½

PER CENT. OF THE FOUR DIFFERENT GRADES.

Plot.	Long Wrappers.	Short Wrappers.	Total per cent. of Wrappers.	Tops.	Seconds.
A	45	20	65	14	21
B	43	25	68	13	19
C	47	19	66	14	20
D	58	16	74	9	17
E	39	20	59	21	20
F	42	23	65	15	20
G	51	16	67	12	21
H	56	16	72	10	18
I	52	19	71	12	17
J	58	16	74	10	16
K	49	22	71	10	19
L	52	25	77	7	16
M	45	19	64	15	21
N	44	18	62	14	24
O	39	16	55	21	24
P	25	11	36	24	40
Q	56	20	76	12	12
R	41	21	62	17	21
S	55	21	76	11	13
T	53	15	68	13	19
U	57	17	74	9	17
V	50	16	66	13	21
W	47	15	62	15	23
X	53	18	71	12	17

* Calculated to $\frac{1}{10}$ acre.

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Mr. DuBon's Notes while Sorting.

A Color dark, quality good.
B Color very light, quality *extra*.
C Color light, quality good.
D Fine, color inclined to light, quality good.
E Inclined to be dark, quality medium.
F Color light, extra good quality.
G Somewhat darker than C, quality good.
H Not recorded.
I Color very dark, quality good.
J Color medium dark, quality good. Not as good as K.
K Color light, good quality.
L Color light, *extra* good quality.
M Color medium light, quality fairly good.
N Color light, quality fairly good, a little heavy.
O Not recorded.
P Color light, quality poor.
Q Color dark, good quality, above medium weight.
R Color a little dark, quality fair.
S Color a little dark, quality good, size a little large.
T Color dark, quality good, a little heavy.
U Color a shade lighter than V, quality fair.
V Color dark, poor quality, heavy.
W Between plots V and U in quality and color.
X Color dark, quality medium.

Number of Leaves to the Pound.

	Long Wrappers.	Short Wrappers.		Long Wrappers.	Short Wrappers.
A	79	106	M	85	106
B	83	106	N	74	97
C	76	98	O	79	118
D	73	107	P	100	132
E	70	97	Q	65	92
F	79	101	R	98	118
G	75	101	S	54	95
H	71	107	T	62	82
I	75	89	U	61	86
J	67	81	V	76	109
K	68	96	W	64	103
L	80	112	X	62	97

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COMPARATIVE CAPACITY OF HOLDING FIRE.*

	Long Wrappers.	Short Wrappers.	Calculated from the mean of both.
A	184	143	170
B	153	195	186
C	177	276	244
D	188	202	207
E	140	165	162
F	303	343	343
G	189	227	222
H	127	230	193
I	146	228	202
J	161	240	215
K	122	208	178
L	154	201	190
M	148	123	142
N	115	180	158
O	171	221	209
P	281	311	315
Q	132	100	121
R	189	190	200
S	129	202	173
T	100	160	141
U	131	138	142
V	126	147	145
W	110	138	100
X	103	130	124

APPEARANCE OF THE ASH OF LEAF WHEN BURNED AS A WRAPPER.

A Light gray, a little muddy.†
B Light gray, a little muddy.
C Light, but darker than B or D. Inclined to flake slightly.
D Light gray. Not muddy. Coals more than A and B. More flaky.
The ashes of the above are a shade darker than those of the next four.
E Light gray, rather more coal than A, B, C, D. Not flaky. Darker and muddier than G, H.
F About like E.
G Light gray, not quite as light as H. Very little muddy.
H Light color. Very flaky. Very little muddy.
I Not quite as light color but otherwise like H.
J Quite light color. No flake. Little muddy. Much like N. Very little coal.
K As light colored ash as any. Very little muddy. A little flaky.
L Quite light color. Like K and M, but not as flaky as either.
M Quite light. Little flake. No mud.
N Light gray. Not as light as S. Smooth, no flake. A little muddy.

* For explanation see page 17.
† That is, having a light brownish shade.

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O About like N.
P A dark gray ash. *Much* darker than any other. No flake.
Q Very much like R, but a little more coal.
R Little darker than S. Somewhat flaky. A little muddy.
S Light as any except H. Slightly muddy.
T Quite light. Bad coal.
U Quite light. Very little flake.
V Darker than W and X. Bad coal.
W Light gray. No flake. More muddy than X.
X Light gray. More flaky than W. Very slightly muddy.

Discussion of the Results.

A single year's experiment cannot be expected to show conclusive results. It is only when the results of one season with another, of wet and dry summers, cold and hot years are studied together that the general value of a particular kind of fertilizer or method of curing can be fairly judged.

Moreover the real value of a tobacco crop cannot be fairly determined when it is cured, stripped and sorted.

Dealers in leaf tobacco all agree that it is easy to be mistaken in judging of the real value of a crop for wrappers, before it has gone through the fermentation or "sweat" in the case.

But while for the reasons just given no final judgment on the crops is attempted by the chosen experts, we may briefly call attention to some of the facts shown in the tables already given.

Net Weight of the Sorted Tobacco and Color of Crop.

The weight alone of course is of the least value in judging of the crop. A very heavy crop of large, dark, thick leaves is much less valuable than even a small crop of fine, medium-sized, light colored leaves, provided the burning quality of both kinds is alike.

There were seven crops of over 2000 pounds per acre, namely:

Q	Baker's Fertilizer	2280 pounds.
U	Mapes' Fertilizer	2270 "
J	210 lbs. nitrogen; half as castor pomace and half as nitrate*	2210 "
T	Ellsworth's Fertilizer	2200 "
S	Bowker's Two Ton Formula	2055 "
I	210 lbs. nitrogen, half as castor pomace and half as nitrate†	2035 "
H	210 " " all in form of castor pomace	2005 "

* See page 7. † See page 6.

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The colors of the pole-cured leaves are described as "very dark" from plot I; as "dark" from plots Q, T, and U; as "medium dark," J; and as "a little dark," S. The color of H is not reported.

On the average the castor pomace plots produced a very little more than the corresponding cotton seed meal plots, 1866 pounds against 1771 pounds, the average difference amounting to 95 pounds per acre. The difference in yield of wrappers was, however, only 17 pounds per acre in favor of the castor pomace. The difference in color was slight, that raised on cotton seed meal inclined to be lighter than that from pomace. The lightest colors of all were in tobacco from the plots fertilized with cotton hull ash and either cotton seed meal or castor pomace. The single exception is plot P, raised on nitrate of potash and Cooper's bone, which was the lightest in the experiment; but the yield from this plot was very small and the burn was poor.

With the same quantities of nitrogen and phosphoric acid a like quantity of potash in form of double sulphate of potash and magnesia, gave a larger total crop and a larger weight of wrappers than either cotton hull ashes, high grade sulphate of potash or carbonate of potash (compare plots K and L with A, M, N and O). There was no very great difference in the color of the crops raised on these different forms of potash. That on A is dark, but on B, C and D, which also received the same quantities of cotton hull ashes with larger quantities of nitrogen, the color of the tobacco was light.

Plot P received only nitrate of potash and bone, the latter containing very little nitrogen. The tobacco on this plot appeared abnormal during all the season and was late in ripening. The total crop was only at the rate of 1250 pounds to the acre and of this only 455 pounds were wrappers.

Per Cent. of Wrappers in Crop.

It appears that a large yield is generally accompanied with a large percentage of wrappers. Of the ten crops which had more than 70 per cent. of wrappers in them six produced more than 2000 pounds to the acre and all of them over 1800 pounds.

Number of Leaves to the Pound of Wrappers.

This point, together with the burning quality of the leaf and the color, most largely determine the value of wrapper tobacco

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for manufacture. Our Connecticut leaf tends all the time to grow too large; so large that it cuts to great waste in the cigar manufacture. This can be certainly remedied by special attention to the growing of seed. It is an extremely important matter which may well receive the attention of growers.

The determinations of the weight of leaves in these crops was made with thirty leaves of the long wrappers and fifty leaves of the short wrappers on a balance sensitive to the one-thirtieth of an ounce.

From the table it appears that the lightest wrapper leaves (in weight, not color), were in the crops from R, Bowker's; L, double sulphate of potash and magnesia with lime; V, Mapes'; A, B and D, cotton seed meal and cotton hull ash; H, F and G, castor pomace and cotton hull ash; W, Mapes'; M, cotton seed meal and high grade sulphate; and lightest of all, were those from P. On O also the leaves were very light.

The heaviest leaves in the experiment were from plots S, Bowker; U, Mapes'; X, Sanderson; T, Ellsworth; W, Mapes'; Q, Baker; and J, heavy applications of castor pomace and nitrate of soda.

It must be borne in mind that the relative weight of the leaves may be very greatly changed by the "sweat" and that heavy leaves may lose in the "sweat" relatively more substance than lighter ones.

Comparative Capacity of Holding Fire.

This is one of the elements which determines the burning quality of a wrapper. It represents the time during which the leaf will continue to glow after it has been kindled.

The determination was made in the following way. Lighters were prepared according to a plan suggested by Dr. Nessler,* of Karlsruhe, as follows: 80 grams of gum arabic are soaked up in 120 c.c. of water and 40 grams of gum tragacanth in 250 c.c. of water. After 48 hours, when both are thoroughly diffused, 10 grams of powdered nitrate of potash are added and enough pulverized charcoal, about 350 grams, to make a thick mass which can be rolled upon a glass plate sprinkled with powdered charcoal, into sticks about 5 or 6 inches long and as large around as a cigar, and dried with a gentle heat. When these sticks are lighted they will slowly burn, without flame, till consumed, giving a live

* Landw. Versuchs-St, xl, 399.

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coal like the tip of a cigar, which is just adapted to kindle the glow on a leaf.

The leaf is held horizontally over this lighter and brought down on its point till a circular hole is burned, glowing on the edges. It is quickly removed and the number of seconds which elapse till the last spark of fire goes out from the leaf is noted.

Six tests were made on each leaf, three on each side of the midrib, one near the base, one in the middle and midway between midrib and edge of leaf and the third near the tip. Five leaves from each lot of wrappers were thus tested making in all thirty trials from each lot and the average of the thirty was taken to represent the relative glowing capacity of the lot.

The lot which glowed for the shortest time is represented by 100 in the table.

Inspection of the table shows that the tobacco from the following plots glowed longer than that from any other:

Plot F, castor pomace and cotton hull ash; P, nitrate of potash and bone; C, cotton seed meal and ash; G, castor pomace and ash; J, castor pomace and ash with nitrate; O, cotton seed meal and carbonate of potash; D, cotton seed meal and ash.

The tobacco from the following plots glowed for a shorter time than any other:

Plot W, Mapes'; Q, Baker; X, Sanderson; T, Ellsworth; U, Mapes'; M, cotton seed meal and high grade sulphate; V, Mapes'.

Appearance of the Ash when the Leaf was used as a Wrapper.

A single leaf was picked by Mr. DuBon from the long wrappers of each plot during the sorting. He aimed to have it of about average color and from as near the same position on the stalk as could be. From this leaf, wrappers were cut and wound on small cigars (Clark's Little Beauty).

These cigars were then smoked for about one-third of their length in an apparatus specially made for this purpose, which is described and figured below. The cigars, with the ash adhering, were then fastened on pins in vertical position so that the whole series could be examined together and compared.

Description of the Smoking Apparatus.

If a continuous stream of air is drawn through a cigar it is much more liable to burn unevenly, one side more rapidly, than

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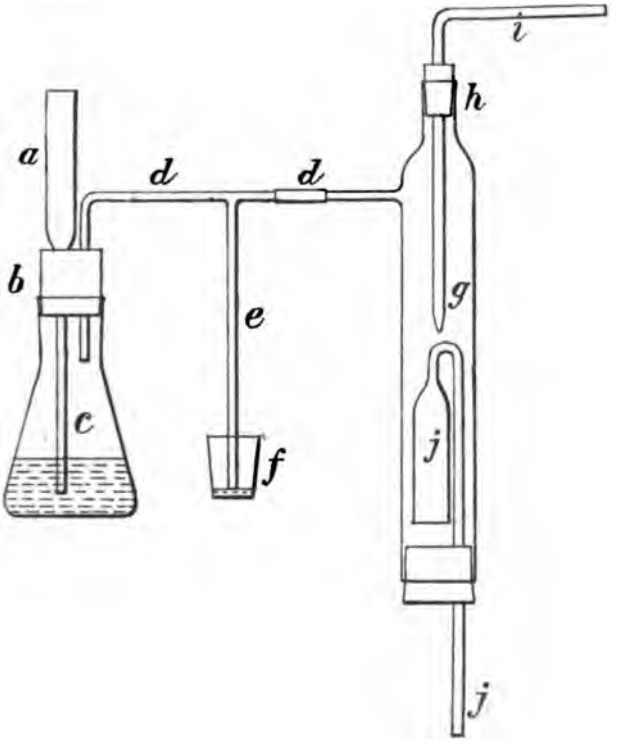
if the draught is intermittent, as when it is "smoked." But the smoking of twenty or thirty cigars in succession, wrapped with unfermented leaves, is quite impossible for "the Station representative" or any one but a confirmed smoker with a sound stomach.

To meet these difficulties and to secure a perfectly uniform rate of smoking and a perfect cone of ash, this apparatus was devised by Prof. S. L. Penfield, of the Sheffield Scientific School, at our request. It has proved to be perfectly adapted to our needs.



The lighted cigar is set upright in the glass holder *a*, a tube which passes through a rubber stopper *b*, nearly to the bottom of the flask *c* of about 200 ccm. capacity, which contains water through which the smoke is drawn. The flask *c* is connected with the other parts of the apparatus by the tube *d*, an arm of which *e* dips very slightly below the surface of mercury contained in the beaker *f*. The other arm of the tube *d*, connects

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with the glass aspirator *g*. This consists of a cylinder of glass, narrow at the top and closed by a rubber stopper *h*. Through the stopper passes the tube *i* connected with a Mariotte bottle. By means of a stop-cock, water may be made to flow into *g* through *i* at a perfectly uniform rate. The lower stopper of *g* carries the syphon *j*, the short arm of which has a much larger diameter than the long arm. The aspirator *g* is held in vertical position by a clamp and *f* and *c* rest on a block of wood. The operation of the apparatus is as follows: The whole being connected as in the figure, the cigar is lighted and tightly inserted in *a*. To insure a good draught a hole may be made from the butt of the cigar for a third of its length with a knitting needle before lighting. A slow stream of water is then allowed to run in at *i*. While *g* is filling, air is forced out through *e* in *f* and there is no current through the cigar.

As soon as *g* fills to the level of the bend in the syphon *j*, the syphon operates and quickly draws off all the water in *g*, thereby making in the tube *d* strong suction which is transmitted to the cigar; that is, the automatic smoker takes a long drawn "pull" at the cigar. As soon as *g* is emptied, the syphon stops running, the reservoir fills again and then takes another puff at the cigar as before. This is allowed to go on till the cone of ash on the cigar is sufficient for the purpose. Then the cigar is carefully removed and mounted for inspection and a new one substituted.

Nothing need here be added to the notes on the appearance of the wrapper ashes as given on page 14.

The test being made only on a single leaf is not entirely satisfactory, though the leaf was chosen with care.

When the tobacco has been fermented a number of cigars wrapped with the leaves of the several plots will be reserved for this smoking test, which will then conclusively determine their burning quality as wrappers.

The Judgment of the Tobacco Experts.

It must be distinctly understood that this judgment is given on the appearance of the unfermented leaves, and it is expressly stated by the experts to be in no sense a final judgment on the quality of the crop.

The relative value of the tobacco from the several plots is liable to very great changes during the fermentation which no one can appreciate or estimate from an examination of the tobacco before it has been cased and fermented.

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Too great emphasis cannot be laid on this, and it is particularly requested that if the experts' judgment is copied or republished, this preliminary statement may always appear with it.

The crop has been perfectly cared for and is in excellent condition. It would probably sell for thirty cents a pound right through.

All things considered from present appearances (December, 1892), the following are the best crops in the lot, the very best being placed at the head of the list and the others following in order of excellence. There is very little to choose between the last of them.

THE BETTER TOBACCOS.

From Plot	Fertilized with
A	1500 Cotton Seed Meal.
	1500 Cotton Hull Ashes.
I	2640 Castor Pomace.
	1500 Cotton Hull Ashes.
	440 Nitrate of Soda.*
G	3300 Castor Pomace.
	1500 Cotton Hull Ashes.
F	2640 Castor Pomace.
	1500 Cotton Hull Ashes.
N	1500 Cotton Seed Meal.
	620 High Grade Sulphate of Potash.
	360 Cooper's Bone, 300 Lime.
K	1500 Cotton Seed Meal.
	1220 Double Manure Salt.
	360 Cooper's Bone.
O	1500 Cotton Seed Meal.
	580 Carbonate of Potash.
	360 Cooper's Bone.

THE POORER TOBACCOS.

The poorest is placed at the head of the list and the others follow, each being better than those above it in the list.

From Plot	Fertilized with
V	501 Lime.
	501 Mapes' Starter.
	2601 Mapes' Tobacco Fertilizer with Extra Potash.
B	2000 Cotton Seed Meal.
	1500 Cotton Hull Ashes.

* One-half at first cultivation, one-half at second cultivation.

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Q	2020	Baker's A. A. Superphosphate.
	3920	Baker's Tobacco Fertilizer.
P	760	Nitrate of Potash.
	500	Cooper's Bone.
T	900	Ellsworth's Starter.
	2700	Ellsworth's Foundation.
R	2000	Bowker's Tobacco Manure.

V has the poorest burn of any. P burns rather black. L has a very little white vein, otherwise K and L are equal in value. There is *very* little if any difference in quality between H and D.

There is not a quarter of a cent a pound difference in the value of the other crops not specially named here and it must be remembered that the last crops named in both lists are not so very far apart in quality.

Chlorine in the Tobacco Fertilizer and in the Crop.

Why certain crops or leaves of tobacco burn well and others burn badly is not fully understood. It is likely that fat and proteids as well as the salts of mineral and organic acids have a decided influence on the burning quality.

But it has been demonstrated that tobacco which contains large quantities of chlorides does not burn well, especially when the quantity of potash present is small. Nessler found* from examination of 46 samples of tobacco grown in different parts of Baden on soils of diverse character, that the more potash and the less chlorine a leaf contains, the longer it will continue to glow when lighted. The higher the per cent. of potash the more chlorine may be present without seriously affecting the burn of the leaf. A Sumatra leaf for instance with .64–.78 per cent. of chlorine and 5 per cent. of potash burned very well, while a Baden tobacco with .4 per cent. chlorine and only 3 per cent. of potash burned badly. On the other hand the less chlorine there is in the leaf, the less potash is necessary to secure a good burning quality. He concludes that no tobacco burns well which has less than 2.5 per cent. potash if there is with it more than .4 per cent. chlorine.

It is therefore of interest to determine the quantities of chlorine applied in the formulas given on pages 6 and 7, as well as the quantities of potash and chlorine in the crops.

* Landw. Versuchs-St., xl, 407.

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Below are given approximately the quantities of chlorine applied per acre in the formulas. The plots not named received very little if any chlorine.

Plot.	Quantity of Chlorine applied per acre.	Plot.	Quantity of Chlorine applied per acre.
I	1.3 pounds.	S	73.2 pounds.
J	1.3 "	U	26.0 "
K	22.0 "	V	31.3 "
L	22.0 "	W	21.9 "
Q	90.5 "	X	12.7 "
R	23.0 "		

The percentages of phosphoric acid, potash and chlorine in the pole-cured (unfermente d) long wrappers and short wrappers were as follows:

Plot.	Phosphoric acid		Potash		Chlorine	
	Long.	Short.	Long.	Short.	Long.	Short.
A	.65	.41	4.25	4.57	.18	.09
B	.39	.33	4.13	4.43	.08	.05
C	.51	.38	5.20	5.09	.11	.06
D	.57	.42	4.61	4.61	.09	.14
E	.75	.70	3.83	3.84	.21	.11
F	.47	.32	5.13	5.06	.05	.05
G	.58	.43	4.94	4.49	.08	.05
H	.44	.32	5.15	4.69	.08	.05
I	.50	.31	3.53	4.36	.16	.08
J	.47	.28	5.28	4.78	.17	.09
K	.48	.30	4.26	4.20	.36	.21
L	.58	.47	4.95	4.73	.08	.07
M	.67	.64	4.83	4.22	.12	.08
N	.45	.38	5.07	4.61	.21	.10
O	.52	.41	4.64	4.42	.07	.05
P	.63	.59	5.04	5.19	.06	.05
Q	.36	.29	3.25	3.90	.56	.47
R	.65	.49	4.72	4.21	.22	.15
S	.41	.31	4.59	4.64	.91	.54
T	.36	.29	3.77	3.58	.25	.15
U	.38	.30	3.80	3.84	.65	.36
V	.33	.29	4.20	4.77	.54	.26
W	.38	.33	5.06	4.59	.42	.21
X	.36	.28	4.45	4.14	.10	.06

Inspection of these figures with those given on page 14 shows: 1st. That of the tobaccos from the nine plots to which any considerable quantity of chlorine had been applied, viz: K, L, Q, R, S, U, V, W, X, six, viz: S, U, Q, V, W, K, had over a quarter

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of a per cent. chlorine in the wrappers and more than any others, and only two out of the nine had the average capacity of holding five, viz: L and R.

2nd. Five lots of tobacco on the other hand, viz: T, M, N, E, A, to which no chloride had been applied and none of which contained over a quarter of a per cent. chlorine, had less than the average capacity for holding fire.

It is not certain that any of these tobaccos have enough chlorine in them to seriously damage their burning quality, and after fermentation has altered the nature of the organic material of the leaf the relative burning quality may be considerably changed.

A certain small quantity of chlorine is absolutely necessary to the normal development of the plant, but growers do well to avoid applying it in other than very small quantities.

FORMULAS FOR TOBACCO.

The investigations made by the Director of this Station in 1872, as chemist of the State Board of Agriculture and those made since then in this Station have shown with sufficient accuracy what ingredients and how much of each are taken from the soil by a crop of wrapper-leaf tobacco as it is grown in this state.

Eight thousand tobacco plants set on an acre of land yield on the average 1875 pounds of pole-cured leaves or 1400 pounds of water-free leaf and 3200 pounds of pole-cured stalks, or about 1300 pounds of water-free stalks.

By this crop there are withdrawn from the soil per acre the following quantities (pounds) of nitrogen and mineral matters:

	In the Leaf.	In the Stalks.	Total.
Nitrogen	65	32	97
Phosphoric Acid	8	8	16
Potash	89	49	138
Soda	4	3	7
Lime	81	13	94
Magnesia	25	5	30
Sulphuric Acid	16	5	31
Chlorine	5	6	11

The crop takes relatively large quantities of nitrogen, (100 pounds), potash, (140 pounds), and lime, (100 pounds), and very little phosphoric acid, (16 pounds).

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On pages 6 and 7 are a number of formulas approved by tobacco growers and by manufacturers.

Among these may be placed A, B, C, E, F, G, and those from Q on through the list. Below are given the number of pounds of nitrogen, phosphoric acid and potash removed from an acre by the crop and the maximum and minimum quantities supplied in these various formulas.

	Removed by Crop.	Supplied in the Formulas.
Nitrogen	100	99—345
Phosphoric Acid	16	150—581
Potash	140	168—643

The minimum quantity of phosphoric acid in any of these formulas is probably much larger than is necessary, the minimum quantities of nitrogen and potash are probably rather too small but the maximum quantities of each ingredient are prodigally wasteful if applied year after year.

Their use the first year might be justified because the land was new and had received no manure in many years, and of course much of the fertilizer applied would not be reached by the roots of the first crop, but would remain as a sort of "working capital" for future crops. Most of the excess of potash and phosphoric acid will be held by the soil till taken up by plants, while the nitrogen is likely to suffer loss by leaching, particularly in very light "tobacco" soils.

But it is certainly irrational to continue the heaviest applications year after year *except for purposes of experiment.*

It is likely also that many growers in their anxiety to secure light color and good burning quality regularly use a good deal more potash and phosphoric acid than is necessary, thus increasing by $10 to $20 per acre the cost of raising the crop. To illustrate:

A favorite formula in the Connecticut River valley, which has given very satisfactory results for the last six years, both as regards total yield, and also color and burning quality of wrappers is 2,000 pounds of cotton seed meal and 1,500 pounds of cotton hull ashes per acre. 2,600 pounds of castor pomace are preferred by some to the cotton seed meal.

As is seen on page 6, opposite plot B, this formula provided 140 pounds of nitrogen, 165 of phosphoric acid and 350 of potash. It contains in round numbers 40 pounds of nitrogen, 145 pounds of phosphoric acid and 210 pounds of potash *in excess* of the

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quantity actually removed by the crop. Considering that all the fertilizer which is applied cannot come within reach of the plant roots in the same season, that a certain excess in the soil is probably favorable to a rapid absorption by the roots of plants, and that nitrogen is specially liable to loss by leaching on the very light soils which are chiefly used for tobacco, the excess of nitrogen in the formula is surely not wasteful. But unless excessive applications of phosphoric acid and potash have some beneficial action on color, burning quality or ripening of the leaf, it must be irrational to apply year after year ten times as much phosphoric acid and two and a half times as much potash as the crop requires.

Whether an excess of phosphoric acid in the soil hastens the ripening of tobacco as it does of some other crops, sugar beets for instance, is not known. Nessler's observations go to show that the more phosphoric acid there is in the soil, the more is taken up by the tobacco plant and that a high percentage of phosphoric acid in the plant is likely to prevent the wrapper from giving a white ash.

Whether any unfavorable action is to be anticipated from excess of potash in the soil is not known and perhaps is not likely. The more potash there is in the tobacco the larger the quantity of chlorine which may be in it without injury to burning quality, and possibly an excess of potash may prevent injury that would otherwise be done by a great excess of phosphoric acid.

It would be desirable in any case to try lessening the expense of growing the crop by diminishing the quantity of cotton hull ashes used and noting whether there was any deterioration in quality. For the formula above given might be substituted for instance 2,000 pounds cotton seed meal and 800 pounds of cotton hull ashes which would supply about 136 pounds nitrogen, 119 of phosphoric acid and 201 of potash.

If 2,640 pounds of castor pomace were used instead of the cotton seed meal, it would supply with the ashes, 17 pounds less phosphoric acid and 7 pounds less potash than the above formula.

But it is likely that the supply of cotton hull ashes will be insufficient this year to meet the demands of the growers. If so, economy in the use of potash and phosphates will be more than ever desirable.

Three hundred and fifty pounds of high grade sulphate of potash, or 650 pounds of double sulphate of potash and magnesia, mixed with 2,000 pounds of cotton seed meal, or 2,550 pounds of

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castor pomace, or 2,600 pounds of linseed meal, old process—which we are informed is to be introduced as a tobacco fertilizer the coming season,—will supply about 140 pounds of nitrogen, 48 to 56 pounds of phosphoric acid and 200 pounds of potash at a cost of from $36 to $43 per acre. Many growers in the Connecticut Valley would prefer to add to this, 200 to 300 pounds of lime to the acre, both to supply lime to the crop and also to maintain a mild alkaline reaction in the soil favorable to the decay and oxidation of nitrogenous organic matters. In the limestone soils of the Housatonic Valley this would probably be of no advantage.

The Connecticut Tobacco Experiment Co., plans to try several of these formulas this season, but it is of great importance that the experiments made in Poquonock should be repeated on soils of different character, the "meadow land" of that vicinity for instance, the different soils of the east bank of the Connecticut River and also in the Housatonic Valley. It is very well known that a system of fertilizing or manuring tobacco very suitable for one soil is much less suited to many other soils.

In the following table are given the average quantities of nitrogen, phosphoric acid, potash and chlorine contained in one hundred pounds of the materials most used in tobacco fertilizers in this State as determined by analyses made at this Station during the last six years:

AVERAGE COMPOSITION OF FERTILIZERS USED ON TOBACCO.

	No. of Analyses.	Pounds per 100. Nitrogen.	Phosphoric Acid.	Potash.	Chlorine.
Nitrate of Soda	13	16.02	....	....	.37
Sulphate of Ammonia	14	20.41	....	....	..
Cotton Seed Meal	35	6.80	2.60	1.70	..
Castor Pomace	23	5.40	1.90	1.10	..
New Process Linseed Meal	..	5.31	2.17	1.54	..
Dissolved Bone Black	19	....	17.05	....	..
Ground Bone	..	4.00	22.00	....	..
Double Sulphate of Potash and Magnesia	15	....	....	26.1	1.8
High Grade Sulphate of Potash	3	....	....	51.4	..
Double Carbonate of Potash and Magnesia†	1	....	....	18.1	.15
Wood Ashes, unleached	35	5.31	1.46	....	..
Cotton Hull Ashes	106	....	9.60	23.90	..
Tobacco Stems	4	1.91	.69	7.70	*
Tobacco Stalks	..	.87	.24	1.66	.20
Horse Manure (with litter)	3	.55	.43	.58	.07
Cow Manure	3	.54	.30	.43	.08

* Not determined. † See page 34.

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See also analyses of the brands of manufactured Tobacco Manures given on pages 98 to 100 of this Report.

By multiplying the number of *hundred* pounds of fertilizer used per acre by the figures above given, may be approximately calculated how much of the three elements of plant food is applied. Thus if 300 pounds of nitrate of soda is used per acre, the quantity of nitrogen applied is (3×16.02), 48.06 pounds.

CHEMICAL CHANGES IN TOBACCO DURING FERMENTATION.

In December, 1891, three lots of tobacco were selected at the warehouse of Mr. A. C. Sternberg of Hartford, as follows: The lots were taken from a pole-cured crop raised with cotton seed meal and cotton hull ashes as a fertilizer.

Lot A was of upper leaves, cut of course when not fully ripe. From a pile ready for casing, two leaves were selected at a time, as nearly alike in color, size and texture as possible and put in two separate piles. Each pile contained 75 leaves which were tied in five "hands." The weight of the two piles was precisely alike, 1 pound 1½ ounces each. The hands from one pile were securely wrapped in oiled paper and brought to the laboratory where they were immediately analyzed, the others suitably labeled, were given to Mr. Sternberg who cased them down with other tobacco to be fermented. Lot B was selected in the way just described, from the "short seconds," the lower leaves on the stalks and therefore a little over-ripe when harvested. Each pile, precisely alike in weight, 1 pound, 9 ounces, contained 175 leaves, and was tied in seven hands. The hands from one were immediately analyzed, those from the other were cased down. Lot C was of "First Wrappers," the best leaves on the stalk, cut at the proper time. Each pile contained 140 leaves, weighed 2 pounds, 1½ ounces, and was tied in seven hands. The one sample was immediately analyzed, the other was cased down. Of this sample only a portion was taken for drying and analysis.

In the latter part of August, 1892, Mr. Sternberg opened the fermented, "sweated," tobacco and immediately sent to the Station the three samples, very carefully packed, to avoid any loss of moisture. The samples were at once dried and analyzed.

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The condition of the tobacco when analyzed in shown in the following table:

	A Upper Leaves.		B Short Seconds.		C First Wrappers.	
	Unfermented.	Fermented.	Unfermented.	Fermented.	Unfermented.	Fermented.
Number of leaves in sample	75	75	175	175	60	60
Weight of the leaves, (grams)	505	456	713	625	401	365
Number of leaves in one pound	67	74	111	127	68	74
Per cent. of water in the leaves	23.5	23.4	27.4	21.1	27.5	24.9

The chemical analyses of the leaves are given in detail below:

ANALYSES OF FERMENTED AND UNFERMENTED LEAVES.

	A Upper Leaves.		B Short Seconds.		C First Wrappers.	
	Unfermented.	Fermented.	Unfermented.	Fermented.	Unfermented.	Fermented.
Water	23.50	23.40	27.40	21.10	27.50	24.90
Ash*	14.89	15.27	22.85	25.25	15.84	16.22
Nicotine	2.50	1.79	.77	.50	1.26	1.14
Nitric Acid (N_2O_5)	1.89	1.97	2.39	2.82	2.59	2.35
Ammonia (NH_3)	.67	.71	.16	.16	.33	.47
Other Nitrogenous matters†	12.19	13.31	6.69	6.81	11.31	11.62
Fiber	7.90	8.78	7.89	8.95	9.92	10.42
Starch	3.20	3.36	2.62	3.01	2 89	3.08
Other Nitrogen-free Extract	29.39	27.99	26.28	28.36	25.52	26.88
Ether Extract	3.87	3.42	2.95	3.04	2.84	2.92
	100.00	100.00	100.00	100.00	100.00	100.00

From the data obtained has been calculated the number of pounds of each ingredient of the leaves in one thousand pounds of the unsweated tobacco, and also how many pounds of each ingredient were left after fermentation. The differences should represent the losses incurred during the process.

* Free from carbonic acid and carbon.

† Nitrogen other than that of nicotine, nitric acid and ammonia, multiplied by 6¼.

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COMPOSITION OF 1000 POUNDS OF UNFERMENTED LEAVES AND THE LOSS OF EACH INGREDIENT DURING FERMENTATION.

	A Upper Leaves.			B Short Seconds.			C First Wrappers.		
	In 1000 Pounds Unfermented.	Left after Fermentation.	Lost in Fermentation.	In 1000 Pounds Unfermented.	Left after Fermentation.	Lost in Fermentation.	In 1000 Pounds Unfermented.	Left after Fermentation.	Lost in Fermentation.
Water	235.9	211.5	23.4	274.0	184.6	89.4	275.0	226.2	48.8
Dry Matter	765.0	691.3	73.8	726.0	692.0	34.0	725.0	683.1	41.9
Ash	148.9	138.1	10.8	228.6	221.5	7.1	158.3	147.5	10.8
Nicotine	25.0	16.2	8.8	7.7	4.4	3.3	12.5	10.5	2.0
Nitric Acid (N_2O_5)	18.6	17.7	.9	23.7	24.8	†1.1	25.9	21.3	4.6
Ammonia (NH_3)	6.7	6.5	.2	1.6	1.4	.2	3.3	4.3	†1.0
Other Nitrogenous matters*	121.0	120.1	.9	67.6	59.7	7.9	113.1	105.6	7.5
Fiber	79.1	79.5	.....	78.9	78.6	.3	99.0	94.8	4.2
Starch	31.9	30.3	1.6	27.6	26.3	1.3	28.9	28.0	.9
Other Nitrogen-free Extract	29.52	252.0	43.2	260.6	248.6	12.0	255.6	244.5	11.1
Ether Extract	38.7	30.9	7.8	29.7	26.7	3.0	28.4	26.6	1.8

Total loss by Fermentation.—The Upper Leaves, Short Seconds and First Wrappers lost respectively, by fermentation, 9.7, 12.3 and 9.1 per cent. of their total weight.

But while three-fourths of the loss in the case of the Short Seconds consisted of water, in the case of the Upper Leaves almost three-fourths of the loss was of dry matter. The First Wrappers lost a little less dry matter than water.

Ingredients of the Leaf affected by Fermentation.—The quantities of nitric acid, ammonia, fiber and starch contained in the leaves are about the same after fermentation as before.

It will be noticed that there is an apparent loss of ash or mineral matter in each case. This cannot possibly be due to changes induced by fermentation but can only be explained by errors in weighing or analysis against which every precaution was exercised, or by the handling of the leaves by the persons who cased it down. Tobacco is usually shaken out very vigorously as it is cased to make the leaves smooth, and in this way adhering sand may be easily shaken out. This latter explanation is the most probable.

Aside from this, the chief loss of dry matter has been in nicotine, albuminoids and amide bodies, nitrogen-free extract and to a much less extent, ether extract.

* Nitrogen other than that of nicotine, nitric acid and ammonia, multiplied by 6¼.

† Apparent *gain!*

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Thus the Upper Leaves lost more than a third of their nicotine, the Short Seconds somewhat less than half and the First Wrappers less than one-sixth of it.

The Upper Leaves in which fermentation was evidently the most active lost more than one-seventh of their nitrogen-free extract and one-fifth of their ether extract.

The First Wrappers claim special notice as they make up a large part and the most valuable part of any good crop.

The fermentation *in this case* destroyed only 5.8 per cent. of their dry matter. They lost but a little nicotine, and aside from the ash the chief losses were of nitrogenous matters other than nicotine and of nitrogen-free extract which includes the "gum" of tobacco.

Further experiments made on a much larger scale are desirable to accurately ascertain the nature of the fermentation and the possibility of regulating it to suit the special requirements of the leaf.

ANALYSES OF TOBACCO STALKS WHEN CUT AND AFTER CURING.

In the summer of 1891, three samples of stalks were taken by Mr. Winton from the standing crop of Mr. H. H. Austin of Suffield.

On August 22, three lots of four plants each were selected with care to secure those that were uniform in size and leaf development.

The plants of one lot, A, were cut at that time, the leaves were at once stripped off and the stalks after weighing were dried at 50° C. for analysis. At this time the lower leaves were ripe, but the whole plant was unripe and not ready to cut for curing on the stalks.

On September 7, a second lot, D, was cut, stripped, weighed and further treated like A. The plants were fully ripe and ready to harvest.

On the same date a third lot, C, was cut, labeled and hung in Mr. Austin's curing barn with the leaves still on it to cure with the rest of the crop. On October 16, the leaves were stripped off and the cured stalks were weighed, dried and analyzed like the others.

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Following are the analytical data which are discussed further on :

ANALYSES OF TOBACCO STALKS.

Sample marked, Date of cutting, Weight when stripped,	A Aug. 22. 4 lbs. 11½ oz.		D Sept. 7. 4 lbs. 14 oz.		C Sept. 7. 1 lb. 11½ oz.*	
	Fresh.	Water-Free.	Fresh.	Water-Free.	Fresh.	Water-Free.
Water	86.46	.....	86.38	.....	61.52	.....
Pure Ash	.90	6.64	.95	7.00	2.87	7.46
Sand and Soil	.19	1.44	.08	.56	.14	.36
Nicotine	.07	.52	.09	.69	.....	.....
Nitric Acid (N_2O_5)	.19	1.40	.23	1.72	.73	1.92
Other Nitrogenous matters†	1.31	10.13	1.56	11.69	6.37	16.69
Fiber	4.76	35.12	4.74	34.79	14.23	36.98
Starch	1.56	11.55	1.94	14.21	4.96	12.91
Dextrose or copper-reducing bodies	.39	2.87	.37	2.71	.25	.66
Other Nitrogen-free Extract	4.05	29.45	3.53	25.67	8.60	22.15
Ether Extract	.12	.88	.13	.96	.33	.87
	100.00	100.00	100.00	100.00	100.00	100.00

The complete analyses of the pure ash are as follows:

ANALYSES OF THE PURE ASH OF TOBACCO STALKS.

	Cut Aug. 22.	Cut Sept 7.	Cut Sept. 7, and Cured.
Silica	.82	.57	.55
Oxide of Iron and Alumina	1.38	1.38	.72
Lime	14.01	16.58	14.85
Magnesia	6.64	7.36	6.91
Potash	56.34	54.46	55.43
Soda	1.28	1.16	.89
Sulphuric Acid	8.06	6.75	7.38
Phosphoric Acid	6.37	6.27	7.96
Chlorine	6.55	7.05	6.82
	101.45	101.58	101.51
Oxygen equivalent to chlorine	1.45	1.58	1.51
	100.00	100.00	100.00
Per cent. of pure ash in water-free Substance	6.64	7.00	7.46

From these data have been calculated how many pounds of the several ingredients were contained in the stalks from an acre of tobacco or 8000 plants and the results are here given :

* Pole-cured.

† Nitrogen (other than that of nicotine and nitric acid) multiplied by 6.25.

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	A Cut Aug. 22. Unripe.	D Cut Sept. 7, Ripe.	C Cut Sept. 7 and Cured till Oct. 16.
Total weight per acre	9437	9750	3438
Water	8159.0	8422.0	2115.0
Dry matter	1279.0	1328.0	1323.0
Starch	147.0	189.0	171.0
Dextrose	38.0	36.0	8.7
Nicotine	6.6	8.8	?
Total Nitrogen	**25.5**	**32.2**	**41.8**
Phosphoric Acid	**5.5**	**5.8**	**7.9**
Potash	**47.8**	**50.6**	**54.7**
Soda	1.1	1.1	.9
Lime	11.9	15.4	14.7
Magnesia	5.6	6.8	6.9
Oxide of Iron and Alumina	1.2	1.3	.7
Sulphuric Acid	6.8	6.3	7.4
Chlorine	5.6	6.5	6.8

These figures show a slight gain by the stalk in almost every ingredient in the period of growth between August 22 and September 7.

If the different samples were exactly alike when cut there would be the same quantity of ash ingredients in the stalks after curing as there was before, for none of them are volatile or could be dissipated by fermentation. We find that they are practically alike except in the case of phosphoric acid and potash which are present in somewhat larger quantity in the cured than in the uncured stalks.

It is quite possible that nitrogen might be lost in the pole curing, but that the plants should acquire nitrogen is not conceivable; yet the cured stalks show 10 pounds more, per acre, than the uncured. This is to be explained by inequality in the samples which were drawn, unless indeed there has been, as some claim is possible, a transference of nitrogen (and to a less extent of phosphoric acid and potash) from the leaves to the stalk, during the curing process.

In curing, the stalks seem to have lost some starch by fermentation and the larger part of the sugar which they originally contained.

The analyses are principally interesting as showing the weight of the stalks and also the plant food which they take from the land while growing and return to it when plowed in.

The stalks on an acre of tobacco containing 8,000 plants weigh at the time of cutting about 9,500 pounds. Of this about 8,300 pounds or 4 1-7 tons is water, which has to be handled and hauled to the barns and hung on the poles. About 6,200 pounds, 3 1-10 tons, of water is evaporated

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in curing and the rest, a little over a ton of water, is taken down and carried back to the field in the cured stalks.

Averaging the data here given with other data collected by this Station in past years, the valuable fertilizing ingredients in the stalks from an acre, of 8,000 plants, of tobacco is as follows:

FERTILIZING INGREDIENTS IN STALKS [8,000] FROM AN ACRE OF TOBACCO.

	Average pounds.	Maximum pounds.	Minimum pounds.
Nitrogen	32	42	22
Phosphoric Acid	8	15	6
Potash	49	55	51
Soda	3	10	0.5
Lime	13	15	8
Magnesia	5	7	2
Sulphuric Acid	5	7	3
Chlorine	6	11	trace

A NEW POTASH SALT FOR TOBACCO.

The Station has received from the Stassfurt Syndicat, for use in the experiments on growing tobacco, one ton of their double carbonate of potash and magnesia. This salt has lately been put on the German market and is being tested by the tobacco growers of Baden and Elsass.

It is a very fine powder, dry to the touch, and a sample drawn by the Station agent from the ton lot has the following composition:

Potash	18.10
Soda	1.49
Lime	1.20
Magnesia	19.27
Oxide of iron and alumina	2.34
Chlorine	.15
Carbonic acid	32.55
Water, mostly combined	25.12
	100 22

The composition of this article may also be represented as follows:

Hydrous Carbonate of Potash	31.74
Hydrous Carbonate of Magnesia	60.21
Carbonate of Soda	2.32
Carbonate of Lime	2.14
Chloride of Sodium	.24
Oxides and carbonates of iron	3.35
	100.00

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The quantity of chlorine present is too small to be of any significance for tobacco.

This material contains five or six per cent. less of actual potash than cotton hull ashes contain on the average, but seems to be well adapted for use on tobacco in place as either cotton hull or wood ashes.

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REPORT OF THE MYCOLOGIST.

WM. C. STURGIS.

The past season has been an exceptionally favorable one for the farmer and fruit-grower so far as the prevalence of fungous diseases is concerned. The prolonged dry weather which marked the middle of June, the latter part of July and of August, and the first half of September, was most unfavorable to the development of parasitic fungi, fruit and garden crops suffered little if at all, hence the work of the mycological department was largely confined to a continuation of the experiments begun the previous year.

TOBACCO.

The work of this department upon tobacco this year was entirely of a preparatory nature.

As outlined in the Station Report for 1891, it was intended to try the value of artificial heat in counteracting unfavorable atmospheric conditions during the process of curing, resulting in the decay known as "pole-sweat." With this and similar ends in view, and in connection with the newly organized Connecticut Tobacco Experiment Co., a plot of land was secured for a term of years at Poquonock, and steps taken for an extensive series of experiments upon the fertilizing of tobacco and the quality of the product under various conditions of fertilization. The results of these experiments have already been published by the Station. Meanwhile a curing-barn built upon the principles of ventilation suggested in the Station Report for 1891, was erected upon the Company's land. The amount of tobacco planted for experimental purposes exceeded that originally proposed, so that it became necessary to alter the plans first made and make the barn considerably larger. The present structure is 60 ft. long by 31 ft. wide, and measures 16 ft. 8 in. from sill to eaves. The land upon which the barn is built slopes slightly, necessitating brick foundation piers to bring the sills level. The studs erected on the sills are 15 ft. apart, thus providing for the use of the usual fifteen-foot poles running the length of the barn, the ends of each pole resting upon

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the heavy girders which connect the studs on the opposite sides of the barn.

The lower tier of poles rests on girders at a height of 6 ft. above the floor, the two upper tier spaces are each 5 ft. 4 in. high. This permits of one tier space 5 ft. high in the roof. The doors occupy one half of each end of the barn, thus allowing for a driveway 15 ft. 6 in. wide running the full length of the barn.

The building is so constructed as to be weather-proof in case of need, while free circulation of air is secured by horizontal rows of ventilators opening just above the sills and opposite each tier of poles. These ventilators are 7 ft. 6 in. long by 1 ft. wide and occupy all four sides of the barn except where replaced by the doors; they are hinged along the upper edge so as to be opened or closed at will. This system of ventilation permits of a free access of air just below the tips of each tier of plants as they hang in the barn, and precludes all possibility of damage from the air striking the plants directly as is the case where vertical ventilators are used. To assist further the circulation of air, especially when artificial heat is used in the barn, the gables are each provided with a large swinging ventilator which can be closed when necessary.

The total cost of this barn, not including the heating apparatus, was $657.56.

To find some system of heating the barn which should be both cheap and easily applicable to the style of barn at present in use, was a matter requiring some thought. It was finally decided to use seven and eight inch galvanized iron stove-piping for the flues, and for furnaces very simple stoves of sheet-iron. In laying the flues advantage was taken of the slope of the land. The furnaces, four in number, were placed along the lower side of the barn on the outside, and sunk so that the smoke-flue came within a foot of the surface of the ground. The flue was then continued within the barn until it reached the drive-way where it was sunk a few inches below the surface to allow of planks being placed over it so that the drive-way could be used when the flues were in position. The accompanying diagram illustrates the ground-plan of the flue-systems.

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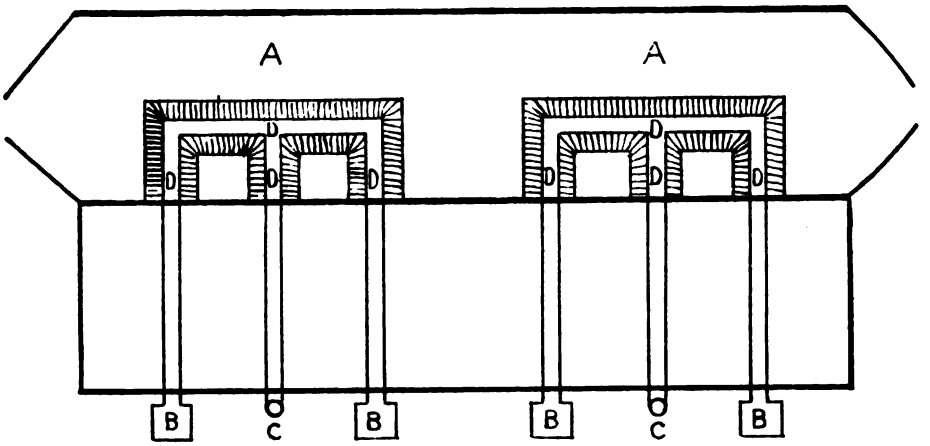

A, A, represent the driveway; B, B, B, B, the furnaces; the portion of the flues marked D is sunk below the level of the floor in trenches with sloping sides, indicated by the shaded portion. The whole drive-way can be covered with planks which are easily removed whenever the heat from the flues is required. The central flues of each system issue from the barn at C, C and connect with tile chimneys resting upon suitable brick foundations.

It will be noticed that this plan differs from that previously suggested, in that here the flues run across the barn instead of lengthwise, this change being necessitated by the greater length of the barn. Had the ground been level, of course the furnaces would have been sunk deeper so as to allow of the flue being laid on a slight incline sufficient to establish a draught, and yet be below the surface at the drive-way; but as the ground itself sloped considerably the flues could be a foot above the surface at B, rise gradually six inches in twenty feet, and yet be below the surface at D.

The total cost of the furnaces, flues, and chimneys amounted to $84.37 including labor; and with proper care, especially if the flues and furnaces are painted, the whole apparatus would last some years.

The flues were tested, and were found to be amply sufficient to raise the temperature of the air in the barn to any required degree, and to establish a current of warm air passing off through the ventilators in the eaves. Whether the latter will be sufficient to prevent an accumulation of hot air in the upper part of the barn,

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remains to be seen. It may still be necessary to provide additional ventilation in the roof.

The barn was completed and the flues adjusted August 26th. The tobacco was cut and hung August 29th and 30th. On September 6th, 13th and 14th, there were heavy showers, but with these exceptions, until the first of November the weather was clear and cool with light northwesterly winds. No "pole-sweat" was to be found, and it was therefore impossible to continue the study of the organism producing the decay. It is possible that another season will present an opportunity for further investigation, and for experiments in preventing "pole-sweat" by the judicious use of artificial heat at critical periods of the curing process. We have at least devised a cheap and ready method of applying heat, and one easily applicable to any curing barn.

Potatoes.

Through the kindness of Mr. H. M. Yerrington of Norwich, four acres of potatoes on his farm were secured by the Station for the purpose of experimenting on a large scale with various fungicides in preventing potato blight and rot. Potatoes grown on this land had in previous years suffered considerably from the disease, and it was reasonable to presume that the conditions for an instructive experiment would again prevail. The potatoes were grown in two fields, the one containing two acres and a half, situated on dry upland; the other, distant about a quarter of a mile, situated on sloping ground protected by woods from excessive dryness, and containing an acre and a half. The upper field was reserved for experiments with Bordeaux mixture of two different degrees of strength, the lower for testing the comparative efficacy of acetate of copper in suspension, and an ammoniacal solution of sulphate of copper, using carbonate of ammonia as a solvent according to Johnson's formula.

The "seed" used in both fields was the same, consisting of three varieties: Polaris, Summit, and New Queen. Part of the "seed" was northern, and part native. It may be incidentally mentioned here that the northern "seed" proved by far the best, producing nearly double the yield of the native "seed."

The conditions of growth were further equalized by the use of the same fertilizers on the two fields; Williams & Clark's, Chittenden's, and Coe's, 500 lbs. to the acre broadcast, and 1,500 lbs. in the drills. On June 15th, both fields were staked off, the

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upper into three plots covering respectively one acre, one acre, and one-half acre; the lower into two plots, one covering an acre, the other half an acre. The first application of the fungicides was made the same day. A cask containing 50 gallons was mounted on a farm wagon, and fitted with a Gould double-acting force-pump provided with two discharge tubes each fifteen feet in length, and Vermorel nozzles. One man was required to drive, one to pump, and one to direct each spray. A little experience showed that the most expeditious method of using a rough contrivance of this nature was to drive the cart so that two rows came between the wheels; by stopping for a few seconds every twenty or thirty feet the man directing each spray could spray one row beneath the wagon and three on the side, making eight rows treated simultaneously. By attaching each nozzle and tube to a light stick four feet long, the labor of applying the spray was much decreased. There is no doubt that a great deal of time and energy was unnecessarily consumed by this inadequate method of applying the fungicide, and we hope before another season to perfect a cheap and simple device for spraying potatoes, by which one or at most two men will be enabled to spray three or four rows simulanteously as fast as a horse can walk. Even by the method described above, four men could spray an acre and a half in two hours although much time was lost in the frequent turns necessitated by the narrowness of the field. It was feared that much damage would be caused by running over the vines at each turning, but it proved much less than was expected, the vines being only slightly crushed even when almost full-grown, and recovering very quickly.

On the three plots comprising the upper field, which we will call A, B, and C, (C being the half acre) the fungicide used was sulphate of copper. Plot A received Bordeaux mixture in the proportion of 6 lbs. sulphate of copper and 5 lbs. lime to 50 galls. of water, this being about half the strength usually recommended. Plot B received the same diluted with twice the amount of water, viz: 6 lbs. sulphate, and 5 lbs. lime to 100 galls. of water. Plot C was sprayed with sulphate of copper alone in the proportion of ½ lb. to 40 galls. of water. With the fungicide applied to plots A and C Paris green was mixed, in the proportion of ½ lb. to 50 galls.; and plot B received ¼ lb. of Paris green to 50 galls. In the centre of the field three rows were left as checks. These received only Paris green.

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The two plots comprising the lower field we will call D, and E, the latter being the larger. Plot D was sprayed with acetate of copper 10 oz., Paris green ¼ lb., water 40 galls. Plot E received the ammoniacal solution of sulphate of copper in the proportion of 1 lb. carbonate of ammonia, ½ lb. sulphate of copper, dissolved separately, and diluted with water to 62 galls. One corner of this field comprising about one-tenth of an acre was left untreated as a check.

The first spraying on all the plots was begun on June 15th and finished the following day. The vines made a very strong growth during the next three weeks and as there was no appearance of the rot, and the weather was comparatively dry, the second spraying was deferred until July 6th. On this date the vines were in full bloom and so high that it was evident that a third spraying would be impracticable. On July 16th the vines on the lower field began to blight, though no Phytophthora was to be found ; the cause of the blight was not determined, inasmuch as the vines had dried and were completely dead before they could be submitted to sufficient microscopic examination.

The potatoes on the upper field, especially those sprayed with the stronger Bordeaux mixture, made a good growth and remained comparatively green until the latter part of August when digging was begun, and finished September 10th. The plots sprayed with Bordeaux mixture yielded an average of 291 bushels per acre; the plot treated with the ammoniacal solution of copper sulphate, 146½ bushels per acre; the plot treated with acetate of copper, 181 bushels per acre ; and that treated with the simple solution of sulphate of copper, 272 bushels per acre.

Under date of November 8th, Mr. Yerrington writes with reference to the crop from the upper field where the Bordeaux mixture was used: "The potatoes are considered something wonderful here as the crop generally is a failure."

Although no Phytophthora appeared upon sprayed or unsprayed potatoes in this section and the experiment is therefore valueless as far as this disease is concerned, it is nevertheless instructive, and justifies the following conclusions:

1. Bordeaux mixture, even of half the usual strength, viz: copper sulphate 3 lbs., lime 2 lbs., water 22 galls., exercises a marked effect upon potato vines, considerably increasing their vitality and period of growth.

2. In this respect Bordeaux mixture is superior to the ammoniacal solution of copper sulphate, and to copper acetate.

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3. The ammoniacal solution of copper sulphate prepared according to Johnson's formula has one serious objection. The carbonate of ammonia is not only difficult to procure in a perfectly fresh condition, but upon exposure to the air loses water and ammonia, becoming in the course of a few days soft and opaque, in which condition considerably more of the salt is required than when fresh, to dissolve the same quantity of copper sulphate. It is possible of course to procure the ammonia salt fresh and make up at once a sufficient quantity of the concentrated solution of copper sulphate to last during the season, but the quantity required for a season's spraying is not often known accurately, and on the whole it would seem more convenient to use liquid ammonia as a solvent for the copper salts.

4. The expenditure of time and labor in the application of Bordeaux mixture to potato vines, even with imperfect apparatus and methods, is much less than would be expected; the labor of three or four men for 1 hr. and 20 mins. being sufficient to apply the mixture thoroughly to an acre of potatoes almost fully grown. If the mixture is prepared in the proportion of copper sulphate 6 lbs., lime 4 lbs., water 50 galls., the cost of chemicals would be about 28 cents per acre for each application, about 63 galls. being required to spray that area.

An experiment similar to the above was conducted by Mr. F. T. Bradley, of Saybrook. Mr. Bradley used the Bordeaux mixture and a knapsack sprayer. Under date of November 16th he reports as follows: "So far as efficacy of the treatment is concerned I can say nothing, for there was no "rot" in this section this year. I can spray from three to four acres a day at a cost of material of from 40 cents to 60 cents per acre each time."

QUINCES.

Leaf-Spot. Entomosporium maculatum, Lév.

The experiments of former years in the orchard of Mr. Geo. F. Platt at Milford were continued this year with a view of determining the value of certain other fungicides as compared with the Bordeaux mixture hitherto used with marked success.

The fungicides used were the ammoniacal solution of copper sulphate (carbonate of ammonia as the solvent); modified Eau celeste; acetate of copper in suspension; and a mixture of copper sulphate dissolved in water, and powdered steatite, the latter

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BLACK-ROT OF QUINCE.

Sphaeropsis Malorum. Peck.

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furnished by Messrs. W. S. Powell & Co. of Baltimore. Each of these fungicides was used on two trees, the remainder of the orchard being sprayed as usual with Bordeaux mixture. The fungicides were applied May 24th, June 11th, and July 12th, and at the time of harvesting the crop no marked difference with regard to the prevalence of "leaf-spot," could be observed between these trees and those treated with Bordeaux mixture. At the time of the last spraying a very small amount of "rust" (*Roestilia aurantiaca*, Peck) was to be observed on all the trees in the orchard, attacking a young fruit here and there or a twig. The trees sprayed with the acetate of copper seemed to be more free from rust than any of the others, and this treatment will be continued another year as the acetate is cheap and easily applied.

None of the other fungicides used however, is in any way superior to Bordeaux mixture.

BLACK ROT OF QUINCES.

Sphæropsis Malorum, Peck.

Late in October the writer received from Mr. N. S. Platt of Cheshire several quinces more or less affected with a disease inducing a rapid decay of the fruit.

It was first noticed in August last, as a small brown stain on the exposed side of the fruit; the discolored area rapidly increased in size, the parts affected became shrunken and often badly cracked, and upon cutting the fruit open the interior was found to be brown and decayed to the core, and this notwithstanding the fact that all the trees had received thorough treatment with Bordeaux mixture before the blossoms had opened, again June 14th, and finally July 29th. The appearance of the diseased fruit is represented in the accompanying plate. Specimens of the fruit on which the disease had just appeared were placed upon a table in the laboratory. In the course of ten days the decay had involved the whole fruit, and at the end of three weeks numerous black pimples began to appear on the discolored surface of the now shrunken and wrinkled fruit. Finally the fruit became completely "mummified" and reduced by drying to a quarter of its original bulk.

Microscopic examination of the diseased fruit showed that the decay was caused by the presence of a fungus (*Sphæropsis Malorum*, Peck), the black pimples which appeared from three weeks

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to a month after the disease became apparent on the quinces, constituting the fruiting stage of the fungus. This disease is not peculiar to quinces, but has long been known on apples,* and has been frequently described. The "apple quince" seems to be more subject to its attacks than the "orange quince."

It would seem an easy matter to suggest remedial measures for this disease. It seldom makes its appearance before August when the fruit is well grown, a fact which would sufficiently account for its appearance on the sprayed trees this year, the last treatment being made July 29th. Two additional treatments with Bordeaux mixture in August, or one in August and one in September, would probably prevent its appearance. It is needless to say that every "mummified" fruit allowed to remain on the trees or on the ground beneath them, becomes a centre of the disease the succeeding year. All such fruit should be collected at the time of harvest, and buried, or better still, burned.

CELERY.

Blight. Cercospora Apii, Fres.

Early in July a letter was received from Mr. Gaston T. Hubbard of Middletown, requesting information regarding a disease which attacked and destroyed his celery the previous year. The description of the disease was too meagre to allow of any conclusions regarding its cause, but Mr. Hubbard was recommended to await further developments, and if the disease made its appearance, to send specimens to the Station, and to try dusting part of the plants with powdered sulphur, and using upon another portion a spray of sulphide of potassium in the proportion of ¼ oz. to 1 gall. of water. The recommendation was a mere hazard, as it seemed improbable that any fungicide would check a disease once started, and yet it was desirable to allow the disease to start in order that its nature might be determined. About Sept. 10th, specimens of diseased leaves were sent to the Station, and upon examination proved to be attacked by the common leaf-blight of celery, *Cercospora Apii*, Fres.†

Meanwhile the treatment recommended had been carried out since Sept. 1st, when the blight first showed itself. The result of the sulphur treatment seemed satisfactory, although owing to the

* F. L. Scribner, Fungus diseases of the Grape and other Plants, p. 81.

† Twelfth Annual Report N. J. Agr. Exp. Station, p. 250, 1891.

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pressure of other work, personal supervision of the experiment by the writer was impossible, and none of the plants were left untreated as checks.

Under date of Nov. 5th, Mr. Hubbard reports: "The disease began to show about Sept. 1st, and I at once dusted half my crop with sulphur, spraying the other half with the potassium sulphide solution. I soon saw that the sulphur was proving the more effective, and henceforth used it on the whole crop. I dusted the plants four times, using two pounds each time on 1,200 plants. Last year I lost my whole crop by this disease. This year the disease was checked by the treatment and I have not lost a plant."

In accordance with past experience the sulphur was applied upon a warm day, in full sunlight, the commonly accepted theory being that under such conditions sulphur gives off a gas destructive to vegetable life, and known as sulphurous acid. This theory does not seem to have sufficient foundation in fact, sulphur being stable except at very high temperatures. We can only say with certainty that at moderately high degrees of temperature sulphur does exert a fungicidal action even when not in contact with any part of the fungus, and that consequently this action, whatever be its cause, is more marked in direct sunlight than upon a cool or cloudy day.

ASTERS, &c.

A DISEASE CAUSED BY NEMATODES.

On August 4th, 1892, I received from Prof. Galloway of the United States Department of Agriculture, two packages of diseased Asters which had been sent to the Department from Hartford, Conn.

Further investigation showed that the disease was not local, but wide-spread throughout New England. Nor was it confined to asters; calendulas, marigolds, and zinnias, all showed similar symptoms of disease. As it appears on asters, the disease is first manifested when the plants are about three inches high. The younger portions of the plant begin to put out long, spindly shoots which are provided here and there with dwarfed and misshapen leaves. These shoots present an unhealthy appearance as though grown in the dark; they are of a pale-yellow or whitish color, and eventually produce dwarf flowers which, like the shoots themselves, are bleached or etiolated. From the bleached and spindly appearance of the plants, the diseased condition is known among florists as "white-legs."

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One symptom which, as far as I have observed, always accompanies the disease, has been overlooked by those who have examined the diseased plants. At a late stage of the disease the stem of the plant exhibits signs of decay beginning near the ground and gradually spreading upwards until sometimes the whole stem, especially the internal tissue, is involved.

At first sight one would be inclined to accept the usual theory concerning the disease, and conclude that it was due to the parasitic "blue aphis" which is often found in large numbers upon the roots. But certain considerations seem to preclude this view, though doubtless the aphides are in a measure responsible for the diseased appearance of plants whose roots are infested by them. Correspondence with various florists in Hartford and vicinity elicited the information that the usual remedies against the blue aphis seemed to have no effect in lessening the disease under consideration. Granulated tobacco and sulphur applied liberally to the beds and raked in before planting out the asters were quite inefficient, and no better results followed the application of the same substances at a later period about the base of each plant. Water heated to 140° and poured about the plants proved equally unavailing. The fact thus indicated, that the aphis was not the primary cause of the diseased condition of the plants, received further confirmation from a careful examination of the plants. Some of the specimens sent to me exhibited the characteristic symptoms of the disease, and their roots were swarming with the aphis. Others presenting the same symptoms, grown under the same conditions, and sent to me at the same time, showed not a trace of the aphis. One large grower last year had a lot of over 2,000 plants from which he did not get a perfect blossom. Four different persons examined the roots of these plants from time to time and were unable to find any signs of the aphis. There were plants in the neighborhood of these which showed no symptoms of disease and flowered profusely, yet, on examination of the roots, they were found to be covered with the aphis. These facts led me to examine the roots of the diseased plants more carefully, and as a result the presumable cause of the disease was found in the presence upon the roots of countless minute spherical or fusiform white galls caused by the attacks of microscopic "eelworms" or nematodes. On crushing or cutting open these galls the worms were seen in several stages of development, generally encysted, but often in the egg or larval condition. Examination

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of the decaying stems showed that the presence of the nematodes was not confined to the roots. The pith and inner tissues of such stems were found in all stages of decay even when appearing healthy externally, and in all cases the decayed tissues were swarming with adult nematodes of more than one species. The leaves and dwarfed flower-heads were examined with care but these organs were found to be free from the direct attacks of the worms.

Specimens of the diseased plants were sent to Prof. G. F. Atkinson, at that time biologist of the Alabama Experiment Station, and he kindly gave his opinion to the effect that the root-galls were caused by a species of nematode, *Heterodera radicicola* Müll., very commonly found in the roots of many plants both wild and cultivated. In the decaying Aster stems, two forms of nematodes belonging to different genera were found and determined by Prof. Atkinson. One of these, belonging to the genus Rhabditis, " is not," he writes " known to be harmful, feeding only on decaying vegetable matter." The other, a species of the genus Aphelenchus, is probably the primary cause of the disease. The various members of this genus are true parasites, feeding upon the tissues of living plants. One of them is known to cause a leaf-disease of Chrysanthemum, Begonia, Pelargonium, Salvia, Zinnia, &c.* Two others have recently been described† from Europe, producing distortions of the flowering axes of the Strawberry.‡ Owing to the lateness of the season it was impossible to continue the study of this subject further, and determine by means of pure cultures and inoculation of healthy plants, whether this nematode were, as it seemed to be, the primary, if not the sole cause of the disease; but enough was seen to warrant some suggestions regarding remedial measures.

All growers agree that asters planted upon new turf ground are exempt from the disease. It is therefore recommended that if it is desired to grow asters consecutively for several seasons in the same bed, six or eight inches of the old soil be removed each year and replaced by decayed and broken turf. If the asters were grown in only small quantities, as good results might be attained by removing the old surface-soil each year, and using in

* B. D. Halsted. Twelfth Annual Report N. J. Agr. Exp. Station, 1891, p. 310.

† Ritzema Bos. Zeitschrift für Pflanzenkrankheiten, Bd. I, Heft 1.

‡ For further information upon the life-history of nematodes the reader is referred to the U. S. Dept. Agric., Div. of Entomology, Bull. 20, and to "Nematode Root-galls," by Prof. Geo. F. Atkinson.

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its place soil sterilized by heat. This could easily be done by means of the device commonly used for drying earth for use in the preparation of asphalt pavement. It consists of a piece of sheet iron, six or eight feet square, bent into a flattened semi-circle, the edges resting upon the ground. A fire of wood is built beneath it, a piece of stove-piping at one end which is partially closed, serves to create a draught and carry off the smoke. Fresh soil is placed upon the heated iron surface, removed after being heated for 10 or 15 minutes, and replaced by more fresh soil. In this way a large amount of soil can be thoroughly and quickly sterilized for garden use.

As to fertilizers, common experience is against the use of barn-yard or stable manure. The cause is apparent upon examination of such manure, as it is found to be a most favorable breeding-place for nematodes, the latter often occurring in whitish masses visible to the naked eye. One grower writes: "Last year over 50% of the asters planted upon manured land were rendered worthless by the disease, while those planted upon turf soil were free from disease and the crop of flowers was excellent." The fertilizers which have given most satisfaction when used in connection with plants subject to nematode attacks, have been as a rule, alkaline mixtures containing but little nitrogenous matter. Kainite or muriate of potash have been used with good success, their effect upon the worms being decidedly deleterious, while nitrogen may be supplied by the liberal use of tobacco dust.

Much can probably be done against nematodes by a proper treatment of the soil previous to planting. Experiments have indicated* that they are susceptible to low as well as high degrees of temperature, and would therefore be very largely destroyed by ploughing or deep spading during the Winter.

Their development and spread is also largely arrested by an alkaline condition of the soil due to the presence of an excess of lime in any form, as was shown by the fact that violets affected by a nematode root disease at this Station upon being transplanted for the Summer into a soil containing a considerable quantity of broken mortar, recovered; the root-galls decayed, and in their place a vigorous growth of new, healthy roots, arose. A top-dressing of lime liberally applied to the beds in the late Autumn, followed in early Spring by a similar application well spaded in would doubtless do much to prevent the disease.

* Bull. 43, Cornell Univ. Agric. Exp. Station, p. 156, Sept. 1892.

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Again, drought is fatal to nematodes. Thorough drainage of beds in which asters or other plants subject to nematode disease, are planted, is therefore essential to success.

Finally, it is evident that any diseased portion of a plant which is allowed to remain in the ground at a sufficient depth to be safe from hard freezing, harbors the worms, and becomes a source of infection the following season. All diseased plants should therefore be carefully pulled and burned in the Autumn while they still are in a condition to provide nourishment to the worms. It is probable that when a crop is thoroughly infected with nematodes, there are very few remaining in the soil, and if the plants are then pulled and destroyed, the soil will be left comparatively free of the worms. So important is this fact that in many localities abroad, before planting a crop known to be subject to nematode disease, the farmer plants the land with some rapid-growing and comparatively valueless crop attractive to nematodes. In these "catch-plants" as they are called, the worms collect and are destroyed with the plants, leaving a free field for the more valuable crop.

It must be borne in mind that these suggestions are tentative and rest upon few very conclusive experiments, but they serve at least to point out the direction from which we must look for help in combating this serious pest. For many of the above suggestions I am indebted to the practical florists of the State, especially to Messrs. John Gérard of New Britain, and C. H. Pember of Hartford, and to the valuable report of Dr. J. C. Neal to the U. S. Department of Agriculture, already referred to.

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THE CONNECTICUT FERTILIZER LAW.

The General Assembly at its session in 1882 passed a Fertilizer Law which went into effect September 1, 1882, and which repealed and took the place of all previous legislation on this subject. The law is still in force without any amendment.

Copies of the law may be had on application to the Station. Attention is specially called to the following requirements.

1. In case of fertilizers that retail at ten dollars or more per ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER shall have provided labels or statements and shall have paid the fee. Sections 1 and 3.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, viz: Nitrogen, Phosphoric acid and Potash. The analysis-fees in case of any fertilizer will therefore be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, in case of any fertilizer selling at ten dollars or more per ton, that a *sealed sample* shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him.

A statement of the per cent. of Nitrogen, Phosphoric acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients: Nitrogen, Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide); that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

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3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price*, shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4.

4. All "CHEMICALS" that are applied to land, such as: Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Lime (Gypsum or Land Plaster), Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 9 of the Act.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 9, that all fertilizers be analyzed and it requires the parties making or selling them to pay for these analyses in part: the State itself paying in part by maintaining the Experiment Station.

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OBSERVANCE OF THE FERTILIZER LAW.

MANUFACTURERS who have paid the Analysis Fees as required by the Law, and FERTILIZERS for which fees have been thus paid for the year ending May, 1893.

Firm.	*Brand of Fertilizer.*
Anderson, W. H., Putnam, Conn.	Ground Bone.
Baker, H. J. & Bro., 215 Pearl St., New York City.	Standard UnXLD Fertilizer. A. A. Ammoniated Superphosphate. Special Potato Manure. Special Corn Manure. Special Tobacco Manure. Pure Ground Bone. Castor Pomace.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Tobacco Manure. " Grain Manure. " Grass Top Dressing. " Potato and Veg. Manure. " Fruit Manure. " Seeding Down Manure. Bowker's Hill and Drill Phosphate. " Ammoniated Bone Fertilizer. " Sure Crop Bone Phosphate. " Farm and Garden Phosphate " Potato Manure. " Potato Phosphate. " Tobacco Grower. " Fish and Potash. " Dry Ground Fish. " Fresh Ground Bone. Gloucester Fish and Potash. Kainit.
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Bradley's Superphosphate. " Potato Manure. " Complete Manure for Potatoes and Vegetables. " Complete Manure for Top Dressing Grass and Grain. " Complete Manure for Corn and Grain. " Pure Fine Ground Bone. " Circle Brand Ground Bone and Potash. " Fish and Potash, Anchor Brand. " Fish & Potash, Triangle A Brand. " B. D. Sea Fowl Guano " Original Coe's Superphosphate. Farmers' New Method Fertilizer. High Grade Tobacco Manure.
Buckingham, C., Southport, Conn.	A1 Fertilizer.

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Firm.	*Brand of Fertilizer.*
Coe. E. Frank, 16 Burling Slip, New York City.	Gold Brand Excelsior Guano. Potato Fertilizer. High Grade Ammoniated Bone Superphosphate. Alkaline Bone. Ground Bone and Potash.
Clark's Cove Fertilizer Co., Boston, Mass.	Bay State Fertilizer. Bay State Fertilizer G. G. King Philip Guano. Potato and Tobacco Fertilizer.
Cooper's, Peter, Glue Factory, 17 Burling Slip, New York City.	Bone Dust.
Crocker's Fertilizer & Chemical Co., Buffalo, N. Y.	Crocker's Ammoniated Bone Superphosphate. " Potato, Hop and Tobacco Phosphate. " Vegetable Bone Superphosphate. " Special Potato Manure. " Pure Ground Bone. " Wheat and Corn Phosphate. " New Rival Ammoniated Superphosphate. " Ammoniated Practical Superphosphate. " Buffalo Superphosphate. No. 2. " Ground Bone Meal.
Cumberland Bone Phosphate Co., Exchange Place, Boston, Mass.	Cumberland Superphosphate.
Danbury Fertilizer Co., Danbury, Conn.	Potato Manure. XL Fertilizer. Tobacco Manure. Tankage. Ground Bone.
Darling, L. B., Fertilizer Co., Pawtucket, R. I.	Animal Fertilizer. Fine Ground Bone. Extra Bone Phosphate. Potato and Root Crop Manure.
Davidge Fertilizer Co., 121 Front St., New York City.	Special Favorite Fertilizer.
Downes & Griffin, Birmingham, Conn.	Ground Bone.
Ellsworth, F., Hartford, Conn.	Shoemaker's Swift Sure Superphosphate. " " " Bone Meal. Collier Castor Pomace.
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern General Fertilizer for Grass and Grain. Great Eastern Vegetable, Vine and Tobacco Fertilizer. Great Eastern General Phosphate for Oats, Buckwheat and Seeding Down.

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Firm.	*Brand of Fertilizer.*
Hull, H. C., Meriden, Conn.	Ground Bone.
Kelsey, E. R., Branford, Conn.	Bone, Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Standard Superphosphate. Ammoniated Dissolved Bone. Success Phosphate. Potato Manure No. 1. Celebrated Ground Bone.
Mapes Formula & Peruvian Guano Co., 143 Liberty St., New York City.	Complete Manure for Light Soils. " " " General Use. " " " A " Brand. Potato Manure. Corn Manure. Tobacco Starter. Fruit and Vine Manure. Peruvian Guano. Fine Dissolved Bone. Tobacco Manure, Wrapper Brand. Seeding Down Manure. Grass and Grain Spring Top Dressing.
Miller, G. W., Middlefield, Conn.	Flour of Bone Phosphate. Pure Ground Bone.
National Fertilizer Co., Bridgeport, Ct.	Chittenden's Complete Fertilizer. " Ammoniated Bone Phosphate. " Fish and Potash. " Ground Bone. Russell Coe's Phosphate.
Nuhn, Frederick, Waterbury, Conn.	Self Recommending Fertilizer.
Olds & Whipple, Hartford, Conn.	Red Seal Castor Pomace.
Pacific Guano Co., Box 1368, Boston, Mass.	Soluble Pacific Guano. Special Potato Manure.
Peck Bros., Northfield, Conn.	Pure Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Bone Fertilizer.
Preston Fertilizer Co., Greenpoint, L. I.	Ammoniated Bone Superphosphate.
Quinnipiac Co., 7 Exchange Place, Boston, Mass.	Quinnipiac Phosphate. " Potato Manure. " Market Garden Manure. " Pure Bone Meal. " Fish and Potash—Crossed Fishes Brand. " Fish & Potash—Plain Brand. " Pine Island Phosphate. " Havana and Seed-Leaf Tobacco Fertilizer. " Dry Ground Fish. Sulphate of Ammonia. Dissolved Bone Black. Sulphate of Potash. Muriate of Potash.

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Firm.	*Brand of Fertilizer.*
Read Fertilizer Co, Box 3121, New York City.	Standard Fertilizer. High Grade Farmers' Friend. Samson Fertilizer. Bone, Fish and Potash.
Reese, J. S. & Co., 10 South St., Baltimore, Md.	New England Favorite Fertilizer. Pilgrim Fertilizer.
Rogers & Hubbard Co, Middletown, Ct.	Pure Raw Knuckle Bone Flour. Strictly Pure Fine Bone. Soluble Potato Manure. Rogers & Hubbard Co.'s Grass and Grain Fertilizer. Fairchild's Corn Formula.
Rogers Mfg. Co., Rockfall, Conn.	Ground Bone.
Sanderson L., 114 Church St., New Haven, Conn.	Old Reliable Superphosphate. Pulverized Bone Meal. Blood, Bone and Meat. Fine Ground Fish. Muriate of Potash. High Grade Sulphate of Potash. Regular Sulphate of Potash. Nitrate of Soda. Sulphate of Ammonia. Dissolved Bone Black.
Wadsworth, D. S., Hartford, Conn.	Tankage.
Wilcox, Leander, Mystic, Conn.	Ammoniated Bone Phosphate. Potato Manure. High Grade Fish and Potash. Dry Ground Fish Guano.
Wilkinson & Co., 51 William St., New York City.	Economical Bone Fertilizer.
Williams & Clark Fertilizer Co., 81 Fulton St., New York City.	Americus Superphosphate. " Potato Phosphate. " High Grade Special. " Bone Meal. " Fine Wrapper Tobacco Brand. Royal Bone Phosphate.

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ANALYSES OF FERTILIZERS.

During the year 267 analyses of fertilizers and manurial waste products have been made. A classified list of them is given on page 63.

Of these a small number were made for private parties and for other experiment Stations to compare and test methods of analysis. The others are given in detail on the following pages.

During April, May and June the authorized agents of the Station visited seventy-one towns and villages in Connecticut and carefully drew 475 samples representing 150 distinct brands of commercial fertilizers.

In this way one or more samples were secured of nearly every brand of fertilizer which is offered for sale within the State. When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agents are instructed in every case to open at least three packages of each brand for sampling, and if the number of packages is large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

As a rule, the Station will not analyze samples—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs, and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. All samples drawn by other than Station agents *must* be drawn in accordance with the Station's Instructions for sampling, and properly certified, if the Station analysis is desired. A copy of these instructions and blank certificates will be sent on application.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a

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copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for explanation or protest, if desirable, before the results are published in the Bulletin.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

Explanations Concerning the Analysis of Fertilizers and the Valuation of their Active Ingredients.

Revised.

Nitrogen is the most rare, and commercially the most valuable fertilizing element.

Free Nitrogen is universally abundant, making up nearly four-fifths of the common air, and appears to be assimilable, with aid of certain bacteria, by leguminous plants (the clovers, alfalfa, peas, beans), and mustard, but cannot nourish cereals or other crops.

Organic Nitrogen is the nitrogen of animal or vegetable matters, which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated.

Ammonia (NH_3) *and nitric acid* (N_2O_5) are results of the decay of *organic nitrogen* in the soil and manure heap, and contain Nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda. 17 parts of ammonia or 66 parts of pure sulphate of ammonia contain 14 parts of nitrogen. 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

Phosphorus is, next to nitrogen, the most costly ingredient of Fertilizers, in which it always exists in the form of phosphates, usually those of calcium, iron and aluminum, or in case of some "superphosphates," in the form of free phosphoric acid.

Soluble Phosphoric acid implies phosphoric acid or phosphates that are freely soluble in water. It is the characteristic ingredient of Superphosphates, in which it is produced, by acting on "insoluble" or "reverted" phosphates, with diluted sulphuric acid (oil of vitriol). Once well incorporated with the soil, it gradually becomes reverted phosphoric acid.

Reverted (reduced or precipitated) Phosphoric acid means strictly, phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid. In present usage the term signifies the phosphoric acid (of various phosphates) that is freely taken up by a strong solution of ammonium citrate, which is therefore

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used in analysis to determine its quantity. "Reverted phosphoric acid" implies phosphates that are readily assimilated by crops.

Recent investigation tends to show that soluble and reverted phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the soluble gives better results on crops, in others the reverted is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric acid implies various phosphates not soluble in water or ammonium citrate. In some cases the phosphoric acid is too insoluble to be readily available as plant food. This is especially true of the crystallized green Canada Apatite. Bone-black, bone-ash, South Carolina Rock and Navassa Phosphate when in coarse powder are commonly of little repute as fertilizers though good results are occasionally reported from their use. When *very finely pulverized* ("floats") they more often act well, especially in connection with abundance of decaying vegetable matters. The phosphate of calcium in raw bones is nearly insoluble, because of the animal matter of the bones, which envelopes it; but when the latter decays in the soil, the phosphate remains in essentially the "reverted" form. The phosphoric acid of "Thomas-Slag" and of "Grand Cayman's Phosphate" is freely taken up by crops.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5) also termed among chemists, phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of fertilizers, which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride).

The Valuation of a Fertilizer, as practised at this station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend chiefly for their trade-value on the three substances, *nitrogen*, *phosphoric acid* and *potash*, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above named Ingredients*, a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

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The average Trade-values or retail cost in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash, as found in New England, New York and New Jersey markets, are as follows:

The Trade-Values for 1892 of Fertilizing Ingredients in Raw Materials and Chemicals.

The average Trade-Values or *retail cost per pound* of the ordinarily occurring forms of nitrogen, phosphoric acid and potash are as follows:

	Cts. per lb.
Nitrogen in ammonia salts	17½
nitrates	15
Organic nitrogen in dry and fine ground fish, meat and blood	16
in cotton seed meal and castor pomace	15
in fine bone and tankage	15
in fine medium bone and tankage	12
in medium bone and tankage	9½
in coarser bone and tankage	7½
in hair, horn shavings and coarse fish scrap	7
Phosphoric acid, soluble in water	7½
in ammonium citrate*	7
in dry ground fish, fine bone and tankage	7
in fine medium bone and tankage	5½
in medium bone and tankage	4½
in coarser bone and tankage	3
Potash as high-grade sulphate and in forms free from muriate (or chlorides)	5½
as muriate	4½

These Trade-values were agreed upon by the Experiment Stations of Massachusetts, New Jersey, Rhode Island, and Connecticut, for use in their respective States during 1892. They are the average prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those raw materials which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations

* Dissolved from 2 grams of the unground phosphate previously extracted with pure water, by 100 c. c. neutral solution of Ammonium Citrate, sp. gr. 1.09, in 30 minutes, at 65° C, with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

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obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as :

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried blood,	Plain Superphosphate,
Azotin,	Dry Ground Fish.
Ammonite,	Bone and Tankage,

Ground South Carolina Rock.

Valuation of Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The organic nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at 4½ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 5½ cents per pound.

In most cases the valuation of the Ingredients in Superphosphates and Specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. These charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts, and finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to $4.50 per ton.

In 1892 the average selling price of Ammoniated Superphosphates and Guanos was $35.28 per ton, the average valuation was $25.46, and the difference $9.82, an advance of 27.8 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of Special Manures the average cost was $38.28, the average valuation $30.70 and the difference $7.58 or 25.0 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of Nitrogen, etc., by the trade-value per pound. We

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thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone*, the sample is sifted into four grades and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton, by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

The uses of the "Valuation" are two-fold:

1. To show whether a given lot or brand of fertilizers is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for analysis cannot decide accurately what is the *form* of nitrogen, etc., while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second-named use of valuation frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth, when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of a year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

The *Agricultural value* of a fertilizer is measured by the benefit received from its use, and depends upon its fertilizing effect, or

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crop-producing power. As a broad, general rule, it is true that Peruvian guano, superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

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CLASSIFICATION OF FERTILIZERS ANALYZED.

The fertilizers and manurial waste products analyzed at the Station laboratory from November 18th, 1891, to January 1st, 1893, were as follows:

RAW MATERIALS COMMONLY USED IN MIXED FERTILIZERS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

Nitrate of Soda	4
Sulphate of Ammonia	1
Dried Blood	1
Cotton Seed Meal	11
Castor Pomace	4

2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*

"Odorless Phosphate"	1
Phosphate Rock	3
Dissolved Bone Black	4
Dissolved South Carolina Rock	2

3. *Containing Potash as the Chief Valuable Ingredient.*

High Grade Sulphate of Potash	4
Double Sulphate of Potash and Magnesia	2
Muriate of Potash	4
Kainit	2

4. *Containing Nitrogen and Phosphoric Acid.*

Bone Manures	22
Tankage	13
Fish	6

MIXED FERTILIZERS.

Bone and Potash	3
Nitrogenous Superphosphates	65
Special Manures	45
Home Mixtures	18

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	25
Wood Ashes	15
Phosphatic Marl	3
Oyster Shell Lime	1
Soap Factory Refuse	1
Horn Waste	1
Wool Waste	2
Tobacco Dust	1
Muck	3
Total	267

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These analysis are discussed in the order above given. In all cases where the contrary is not stated the samples were drawn by agents of the Station from stock in dealers' hands. The regular retail cash prices are given wherever possible. In many cases the actual cash prices paid by purchasers have been less than those here stated.

I. Raw Materials of High Grade Containing Nitrogen as the Chief Valuable Ingredient.

Nitrate of Soda.

Nitrate of Soda is mined in Chili and purified there before shipment. It usually contains about 16 per cent of nitrogen, equivalent to 97 per cent. of pure nitrate of soda. It contains besides, a little salt and some moisture. The usual guarantee is "96 per cent." of nitrate of soda equivalent to 15.8 per cent. of nitrogen.

3457. Sold by National Fertilizer Co., Bridgeport. Sampled by S. E. Curtiss.

3479. Sold by L. Sanderson, New Haven.

3491. Sold by Quinnipiac Co., Boston.

3511. Sold by Mapes F. & P. G. Co., N. Y.

The last three samples were drawn by an agent of the Station.

Analyses.

	3457	3479	3491	3511
Moisture	.29	1.25	1.08	1.22
Insoluble in water	.06	.06	.23	.00
Sodium Chloride, Salt	.40	.80	.40	1.06
Sodium Sulphate	.20	.25	.22	.16
Pure Sodium Nitrate	99.05	97.64	98.07	97.56
	100.00	100.00	100.00	100.00
Equivalent Nitrogen	16.34	16.11	16.18	16.10
Cost per ton	$16.00	$50.00	$50.00	$48.00
Nitrogen costs cents per pound	14.0	15.5	15.4	14.9

Sulphate of Ammonia.

This article, now made on a large scale as a by-product of gas-works, usually contains over 20 per cent. of nitrogen, the equivalent of from 94 to 97 per cent. of sulphate of ammonia. The rest is chiefly moisture. The usual guarantee is 25 per cent. of am-

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monia, which is equivalent to 20.6 per cent. of nitrogen, but commercial sulphate of ammonia commonly contains less than that quantity.

A single sample, **3648**, sold by L. Sanderson, New Haven, contained 20.52 per cent. of nitrogen, equivalent to 24.86 per cent. of ammonia and was sold for $72 per ton, equivalent to **17.5** cents per pound.

Cotton Seed Meal.

The seed of the cotton plant, after ginning to remove the fiber, passes through a mill which hulls or decorticates it. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer.

Sometimes, however, hulls and seed are ground together, making "undecorticated meal" which contains considerably less nitrogen and has correspondingly less money value as a fertilizer or as a feed. When the meal has undergone heating or fermentation, its color changes from a deep yellow to brown or reddish-brown. It is then unfit for cattle food and is sold at a cheaper rate as a fertilizer.

3418. From stock of J. Marsh, New Milford.

3426. From stock of H. K. Brainard, Thompsonville. Sampled by Elam French, Enfield.

3427. Sampled by David French, Enfield.

3441. From stock of Olds & Whipple, Hartford. Sampled by Walter Smith, Windsor.

3442. From stock of Olds & Whipple, Hartford. Sampled by G. H. Fitch, Windsor.

3447. From stock of Olds & Whipple, Hartford. Sampled by E. J. Wells, Windsor.

3451. From stock of E. A. Buck & Co., Willimantic. Sampled by S. O. Griswold, Poquonock.

3469. From stock of Olds & Whipple, Hartford. Sampled by Eugene Brown, Poquonock.

3470. From stock of E. S. Hough, Poquonock. Sampled by Eugene Brown, Poquonock.

3471. From stock of E. S. Hough, Poquonock. Sampled by Eugene Brown, Poquonock.

3495. Breed, Pierce & Co., Boston. From stock of Olds & Whipple, Hartford.

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ANALYSES.

	3418	3426	3427	3441	3442	3447	3451	3461	3470	3471	3495
Nitrogen	7.12	7.45	7.32	7.52	6.99	6.60	6.91	7.11	7.13	7.15	6.97
Phosphoric acid	3.10	...	...	2.15	2.32	3.30	2.56	2.78	2.79	2.80	2.21
Potash	1.80	...	...	.99	1.37	2.13	1.93	1.85	1.90	1.79	1.83
Cost per ton	$29.00	...	...	28.00	27.50	27.00	26.00	26.00	26.00	26.00	25.00
Nitrogen costs cents per lb.	15.9	...	...	15.8	16.3	15.2	14.7	14.1	14.0	14.1	14.3

The last sample, **3495**, was damaged meal, sold at a lower price because of its being "off color."

CASTOR POMACE.

The ground residue of castor beans from which castor oil has been extracted.

3566. Made by H. J. Baker & Bro., N. Y. Sampled from stock of F. S. Bidwell, Windsor Locks.

3450. Sold by Bowker Fertilizer Co., Boston, Mass. Sampled from stock of A. D. Bridge by T. J. Stroud, Shaker Station.

3567. Made by Collier Co., St. Louis, Mo. Sampled from stock of F. Ellsworth, Hartford.

3496. Made by Red Seal Castor Oil Co., St. Louis, Mo. Sampled from stock of Olds & Whipple, Hartford.

ANALYSES.

	3566	3450	3567	3496
Nitrogen	4.61	5.32	5.04	5.56
Phosphoric acid	1.34	2.15	1.73	1.70
Potash	1.08	1.25	1.13	.98
Cost per ton	$23.00	20.00	22.00	22.00
Nitrogen costs per pound in cents	21.6	14.7	18.2	16.6

The sample of H. J. Baker & Bro's pomace is evidently damaged. The manufacturers state that it does not at all represent their season's output. The Station endeavored to secure other samples of this brand from the Conn. market but was unable to find them.

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II. Raw Materials of High Grade containing Phosphoric Acid.

"Odorless Phosphate."

3438. A sample of this material was drawn from stock purchased of Jacob Reese of Phila., by H. Von Tobel, Harwinton. It contained 18.42 per cent. of phosphoric acid and cost $20.00 per ton.

This is Basic Slag from steel works formerly known as "Thomas-slag."

If Basic Slag could be purchased cheaply enough, it would be well worth the attention of those tobacco growers who endeavor to avoid the use of any but a small quantity of sulphates on their land. While it is relatively an "insoluble" form of phosphoric acid, experience has shown that in many cases it is much more readily available to crops than ground rock phosphate, and on some soils meets the requirements of crops as well as an equal money value of superphosphate. On other soils, however, it does not show this equality. See Reports of this Station for 1887, p. 110, also for 1888, p. 112, and for 1889, p. 203.

Dissolved Bone Black, Dissolved Bone and Acid Phosphate.

Superphosphates made by treating waste and spent bone black from the sugar refineries, bone dust, or phosphate rock with oil of vitriol which renders the phosphoric acid largely soluble in water.

Dissolved Bone Black.

3455. Sold by the National Fertilizer Co., Bridgeport. Sampled by S. E. Curtiss, Stratford.

3477. Sold by L. Sanderson, New Haven.

3499. Sold by Quinnipiac Co. Stock of Olds & Whipple, Hartford.

Dissolved Bone.

3456. Sold by National Fertilizer Co., Bridgeport. Sampled by S. E. Curtiss, Stratford.

Acid Phosphate.

3689. Sold by Quinnipiac Co., New London. Stock of Olds & Whipple, Hartford.

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ANALYSES.

	3455	3477	3499	3456	3689
Phosphoric acid, soluble	17.44	16.10	15.46	13.37	6.02
reverted	.06	.52	.25	1.59	5.53
insoluble	.35	.07	none	.67	1.61
Cost per ton	$20.00	26.00	26.00	15.00	20.00
Soluble phosphoric acid costs per pound in cents	5.7	7.8	8.3	4.6	4.8

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

HIGH GRADE SULPHATE OF POTASH.

This material should contain over 90 per cent. of pure sulphate of potash or about the same quantity of actual potash as the muriate, but no more than a trace of chlorine.

3449. Sold by Bowker Fertilizer Co., Boston, Mass. Sampled from stock of A. D. Bridge, Hazardville, by T. J. Stroud, Shaker Station.

3467. Sold by L. Sanderson, New Haven. Sampled by O. B. Phillips, Enfield Bridge.

3481. Sold by L. Sanderson. Sampled by Station agent.

3492. Sold by Quinnipiac Co., New London. Stock of Olds & Whipple, Hartford. For analyses see next table.

DOUBLE SULPHATE OF POTASH AND MAGNESIA.

This material is usually sold as "sulphate of potash" or "manure salts," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27 per cent. of actual potash. Besides some 46–50 per cent. of sulphate of potash it contains over 30 per cent. of sulphate of magnesia, chlorine equivalent to 3 per cent. of common salt, a little sulphate of soda and lime, with varying quantities of moisture.

3480. Sold by Quinnipiac Co., New London. Stock of Olds & Whipple, Hartford.

3482. Sold by L. Sanderson, New Haven.

ANALYSES OF HIGH GRADE SULPHATE AND DOUBLE SULPHATE OF POTASH.

	3449	3467	3481	3492	3480	3482
Potash found	50.26	51.26	50.34	47.84	26.24	26.23
Equivalent sulphate of potash	92.94	94.79	93.13	88.5	48.54	48.54
Guaranteed	95.0	90.0	----	90.0	48.0	48.0
Cost per ton	$55.00	55.00	55.00	55.00	30.00	30.00
Potash costs per pound in cents	5.5	5.36	5.46	5.7	5.71	5.71

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Muriate of Potash.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride) 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water.

It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of actual potash.

3454. Sold by National Fertilizer Co., Bridgeport. Sampled by S. E. Curtiss, Stratford.

3483. Sold by L. Sanderson, New Haven.

3493. Sold by Mapes Branch, Hartford.

3571. Sold by Quinnipiac Co., New London. Sampled from stock of A. P. Wakeman, Saugatuck. For analyses see next table.

Kainit.

Kainit is less uniform in composition than the other potash salts. It contains from 11 to 15 per cent. of potash, more than that quantity of soda, and rather less magnesia. These "bases" are combined with chlorine and sulphuric acid. Unless "calcined" it contains more water than the sulphate or muriate of potash. It is usually sold on a guarantee of 12 to 15 per cent. of potash, or 23 to 25 per cent. "sulphate of potash." It cannot properly be called a sulphate of potash, because it contains more than enough chlorine to combine with all the potash present and there is every reason to believe that its potash exists as muriate and not as sulphate.

3572. Sold by Bowker Fertilizer Co., Boston. Sampled from stock of W. H. Anderson, Putnam.

Analyses of Muriate of Potash and Kainit.

	3454	3483	3493	3571	3572
Potash	50.90	48.65	51.81	51.13	11.93
Equivalent muriate of potash	80.4	76.9	81.9	80.8	18.9
Guaranteed	....	80.0	80.0	80.0	19.7
Cost per ton	$40.00	42.50	42.50	48.00	16.00
Potash costs per pound in cents	3.9	4.37	4.1	4.7	6.7

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IV. Raw Materials containing Nitrogen and Phosphoric Acid.

Bone Manures.

The terms "Bone Dust," "Ground Bone," "Bone Meal" and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease—and if taken from garbage or ash heaps, with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam-tanks to recover grease, and are then dried and sometimes sold as "tankage;" or, finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. The nitrogen of all these varieties of bone when they are in the same state of mechanical subdivision has essentially the same fertilizing value.

1. *Sampled by Station Agents.*

In the tables on pages 71 and 72 are tabulated 18 analyses.

Sample **3594**, Lister's Celebrated Ground Bone, is a mixture of bone and salt cake or sulphate of soda.

Sample **3552**, Bowker's Bone according to the statement of the manufacturer, is made almost wholly from the head bones of cattle, sheep and calves which are slaughtered at the Brighton abattoir, to which some oil of vitriol is added to prevent heating.

This addition of oil of vitriol causes a part of the finer material to clump together in soft "pebbles." These require to be disintegrated by washing or crushing before a mechanical analysis is made.

The oil of vitriol moreover makes a portion of the phosphoric acid soluble in water. Analyzed as a superphosphate this bone contains:

Phosphoric acid, soluble	4.43	per cent.
"reverted"	10.94	"
insoluble	3.26	"

Treated as a superphosphate its valuation will be $33.60, 48 cents higher than is given in the table.

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Bone Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3555	Pure Bone Dust.	Peter Cooper's Glue Factory, 17 Burling Slip, N.Y.	Apothecaries Hall Co., Waterbury.	$28.00
3565	Pure Ground Bone.	H. J. Baker & Bro., 215 Pearl St., N. Y.	J. H. Jennings, Green's Farms.	32.00
3559	Ground Bone.	Plumb & Winton, Bridgeport.	Manufacturer.	30.00
3680	Bone Meal.	Danbury Fertilizer Co., Danbury.	Raymond Bros., South Norwalk.	29.00
			J. B. Beers, Brookfield.	30.00
			Manufacturer.	30.00
3553	Fine Ground Bone.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	H. H. Davenport, Pomfret.	30.00
			S. A. Billings, Meriden.	32.00
			J. A. Lewis, Willimantic.	31.00
			J. E. Holmes, Stratford.	33.00
3551	Pure Fine Bone.	W. H. Anderson, Putnam.	Manufacturer.	35.00
3556	Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Olds & Whipple, Hartford.	35.00
			J. P. Barstow & Co., Norwich.	34.00
			W. W. Cooper, Suffield.	38.00
3561	Swift Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia, Pa.	J. P. Barstow & Co., Norwich.	38.00
			F. Ellsworth, Hartford.	40 00
3557	Chittenden's Ground Bone.	National Fertilizer Co., Bridgeport.	E. P. Matherson, Pomfret.	35.00
3506	Raw Knuckle Bone Flour.	Rogers & Hubbard Co., Middletown.	Daniel Moriarty, South Meriden.	39.00
			Olds & Whipple, Hartford.	36.00
3564	Ground Bone.	Downs & Griffin, Ansonia.	Manufacturer.	30.00
3509	Strictly Pure Fine Bone.	Rogers & Hubbard Co., Middletown.	Manufacturer.	32.00
3552	Fresh Ground Bone.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	H. K. Brainard, Thompsonville.	36.00
			J. E Leonard, Jewett City.	31.00
3560	Ground Bone.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	A. P. Wakeman, Fairfield.	30.00
			G. M. Williams & Co., New London.	35.00
3593	Self-Recommending Fertilizer.	F. Nuhn, Waterbury.	Apothecaries Hall Co., Waterbury.	35.00
3562	Pure Bone Meal.	Williams & Clark Fertilizer Co., 83 Fulton St., N. Y.	D. B. Wilson, Waterbury.	35.00
			Daniel Morgan, Poquonock Bridge.	34.00
			S. D. Woodruff & Sons, Orange.	32.00
3558	Pure Ground Bone.	Peck Bros., Northfield.	D. B. Wilson, Waterbury.	30.00
			Apothecaries Hall Co., Waterbury.	28.00
3594	Celebrated Ground Bone.	Lister's Agricultural Chem. Works, Newark, N.J.	W. H. Parmelee, Essex.	32.00

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Analyses of Bone Manures.—Sampled by the Station.

Station No.	Name or Brand.	Chemical Analysis.		Mechanical Analysis.				Cost per ton.	Valuation per ton.	Percentage difference between cost and valuation.
				Finer than			Coarser than			
		Nitrogen.	Phos. Acid.	1/50 inch.	1/25 inch.	1/12 inch.	1/12 inch.			
										Valuation exceeds cost.
3555	Peter Cooper's Pure Bone Dust	1.96	29.54	49	19	20	12	$28.00	$38.77	27.7
3565	Baker's Pure Ground Bone	3.50	23.67	62	23	15	..	32.00	39.21	18.4
3559	Plumb & Winton's Ground Bone	4.58	21.25	47	26	16	11	30.00	35.99	16.6
3680	Danbury Fertilizer Co's Bone Meal	3.91	23.03	33	28	34	5	30.00	34.79	13.7
3553	Bradley's Fine Ground Bone	3.50	20.43	58	30	12	..	31.00	34.95	11.3
3551	W. H. Anderson's Pure Fine Bone	1.87	24.82	88	10	2	..	35.00	39.22	10.8
3556	Darling's Ground Bone	2.67	24.75	68	22	10	..	35.00	39.14	10.6
3561	Shoemaker's Swift Sure Bone Meal	5.72	22.35	54	36	10	..	40.00	43.06	7.1
3557	National Fertilizer Co's Ground Bone	1.37	30.55	44	20	22	14	35.00	37.47	6.5
3506	Rogers & Hubbard Co's Raw Knuckle Bone Flour	4.03	24.82	48	43	9	..	39.00	41.14	5.2
3564	Downs & Griffin's Ground Bone	4.31	22.11	28	19	26	27	30.00	31.52	4.8
3509	Rogers & Hubbard Co's Strictly Pure Fine Bone	3.92	22.46	32	24	27	17	32.00	33.35	3.7
3552	Bowker's Fresh Ground Bone*	3.23	18.63	40	32	26	2	33.00	33.12	0.4
3560	Quinnipiac Ground Bone	3.34	21.62	53	28	17	2	35.00	35.03	0.1
										Cost exceeds valuation.
3593	Nuhn's Self-Recommending Fertilizer	4.55	20.57	46	20	18	16	35.00	34.19	2.3
3558	Peck Bros' Pure Ground Bone	4.00	21.02	12	21	35	32	28.00	27.13	3.2
3562	Williams & Clark's Pure Bone Meal	3.52	18.93	54	26	18	2	35.00	32.24	8.6
3594	Lister's Celebrated Ground Bone*	3.98	14.83	36	20	19	25	32.00	24.66	29.7

* See remarks on page 70.

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Cost and Valuation.

Excluding 3594, which is a mixture of bone and salts, the average cost of the seventeen brands is $33.12, and the average valuation is $35.90, which is a tolerably satisfactory agreement, though the Station valuation is still higher than is fully justified by the state of the market.

2. *Manufacturers' Samples.* 3. *Samples drawn by private individuals.*

Here are given analyses of samples sent to the Station by the manufacturers. No samples of these brands were drawn by the sampling agents, and it is therefore necessary,—to meet the requirement of the law which calls for an annual analysis of each brand—to analyze the samples deposited at the Station by manufacturers. With these is the analysis of one sample drawn by a private individual.

Manufacturers' Samples.

3587. Ground Bone Meal. Made by the Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

3589. Pure Ground Bone. Made by the Crocker Fertilizer and Chemical Co.

3563. Ground Bone. Made by the Rogers Manufacturing Co., Rockfall.

Sampled by private individual.

3462. Ground Bone, made by J. W. Wadsworth, Hartford. Sampled from stock of R. R. Wolcott by John Hamner, Wethersfield.

ANALYSES OF MANUFACTURERS' SAMPLES AND SAMPLE FROM PRIVATE INDIVIDUAL.

MECHANICAL ANALYSES.

	3587	3589	3563	3462
Fine, smaller than $\frac{1}{60}$ inch	79	27	28	31
Fine medium, smaller than $\frac{1}{25}$ inch	13	21	28	31
Medium, smaller than $\frac{1}{12}$ inch	8	49	42	22
Coarse, larger than $\frac{1}{12}$ inch	0	3	2	16
	100	100	100	100

CHEMICAL ANALYSES AND VALUATIONS.

Nitrogen	2.22	4.33	4.13	3.45
Phosphoric acid	28.25	24.92	23.41	23.19
Valuation per ton	$43.64	36.59	35.18	32.87

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Tankage.

This name is properly applied only to the sediment remaining in tanks where meat scrap with some bone is rendered to separate the fat. After boiling or superheating with steam, the fat rises to the surface of the water and is removed, the soup is run off, and the settlings at the bottom are dried and sold as tankage. Such material contains as large or larger percentage of nitrogen than of phosphoric acid. But the name tankage is also loosely applied to mixtures that consist largely of bone and do not differ greatly in composition from pure bone.

1. *Sampled by Station Agent.*

3679. Made by Danbury Fertilizer Co., Danbury.

3478. Pulverized Bone and Meat. Sold by L. Sanderson, New Haven.

3502. Sold by Olds & Whipple, Hartford.

3592. Blood, Bone and Meat. Sold by L. Sanderson, New Haven.

2. *Sampled by the Manufacturer.*

3588. Made by D. S. Wadsworth, Hartford.

3. *Sampled by private individuals.*

3694. Made by D. S. Wadsworth, Hartford. Sampled by F. H. Stadtmüller, Elmwood.

3448. From Bowker Fertilizer Co., Boston. Sampled from stock of A. D. Bridge, Hazardville, by T. J. Stroud, Shaker Station.

3578. Sold by Williams & Clark Fertilizer Co., N. Y. Sampled by Andrew Kingsbury, Coventry.

3590. Made by Bartholomew & Co., Meriden. Sampled by J. Norris Barnes, Yalesville. For analyses see page 75.

Dried Fish.

The samples whose analyses are here given are unacidulated but are analyzed as superphosphates for comparison with other samples of fish to which oil of vitriol has been added to preserve them.

3570. Sold by Bowker Fertilizer Co., Boston, Mass. Sampled from stock of W. F. Andross, East Hartford.

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Analyses of Tankage.

Station No.	Name or Brand.	Chemical Analysis.		Mechanical Analysis.				Cost per ton.	Valuation per ton.	Percentage difference.
				Finer than			Coarser than			
		Nitrogen.	Phos. acid	$\frac{1}{10}$ inch.	$\frac{1}{4}$ inch.	$\frac{1}{2}$ inch.	$\frac{1}{2}$ inch.			
	1. *Sampled by Station Agent.*									Valuation exceeds cost.
3679	Danbury Fertilizer Co's Tankage	4.25	20.37	59	29	10	2	$30.00	$36.84	18.6
3478	Sanderson's Pulverized Bone and Meat	5.07	20.81	81	15	3	1	35.00	42.23	17.1
3502	Olds & Whipple's Tankage	5.82	17.87	77	18	4	1	35.00	40.03	12.5
										Cost exceeds valuation.
3592	Sanderson's Blood, Bone and Meat	6.50	10.68	52	23	20	5	35.00	29.42	19.0
	2. *Sampled by Manufacturer.*									
3588	Wadsworth's Tankage	2.94	24.87	56	17	13	14	----	36.69	---
	3. *Sampled by private individuals.*									
3694	Wadsworth's Tankage	3.20	24.96	56	17	13	14	----	37.44	---
3448	Bowker's Tankage	7.32	1 36	*	--	--	--	----	25.32	---
3518	Williams & Clark's Tankage	5.00	8.79	48	29	18	5	----	23.16	---
3590	Bartholomew's Tankage	5.34	17.08	40	25	15	20	----	32.65	---

* Very fine.

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3490. Sold by Quinnipiac Co., New London. Sampled from stock of Olds & Whipple, Hartford.

3484. Sold by L. Sanderson, New Haven.

3642. Made by L. Wilcox, Mystic. Sampled from stock of Fred Gallup, New London, J. A. Lewis, Willimantic, H. K. Brainard, Thompsonville, W. W. Cooper, Suffield.

ANALYSES AND VALUATIONS.

	3570	3490	3484	3642
Nitrogen	8.68	8.18	8.77	8.75
Phosphoric acid, soluble	.57	none	.67	.56
reverted	5.14	3.55	3.65	4.12
insoluble	1.77	2.64	2.69	2.39
Cost per ton	$35.00	35.00	35.00	35.00
Nitrogen costs per pound in cents*	15.1	17.5	15.9	15.7

* Allowing 7½, 7, and 2 cents per pound respectively for soluble, reverted and insoluble phosphoric acid.

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MIXED FERTILIZERS.

I. Bone and Potash.

3595. A 1 Fertilizer, made by C. Buckingham, Southport. Sampled by Station agent from stock of R. C. Wilcox, Guilford.

3591. Circle Brand Bone and Potash, made by Bradley Fertilizer Co., Boston, Mass. Sampled by manufacturer.

3569. Ground Bone and Potash, made by E. Frank Coe, New York. Sampled by Station agent from stock of City Coal and Wood Co., New Britain.

Analyses and Valuations.

Mechanical Analyses.*	3595	3591	3569
Fine, smaller than $\frac{1}{10}$ inch	58	52	62
Fine medium, smaller than $\frac{1}{5}$ inch	21	36	20
Coarse medium, smaller than $\frac{1}{2}$ inch	15	12	12
Coarse, larger than $\frac{1}{2}$ inch	6	0	6
	100	100	100
Chemical Analyses.			
Nitrogen	4.06	2.66	1.37
Phosphoric acid	15.44	17.59	10.26
Potash	6.31	5.06	2.90
Valuation per ton	$35.10	34.29	18.89

II. Nitrogenous Superphosphates and Guanos.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on.

1. *Samples drawn by Station Agents.*

In the tables on pages 80 to 87 are tabulated the analyses of forty-six brands made on samples collected by the Station agents.

In the table on page 85 is an analysis of Sanderson's Formula A, No. **3596.** Another analysis of this brand previously made on a sample drawn by our agent from stock of E. B. Clark, Milford, No. **3513,** is given below. The manufacturer objected that this did not fairly represent the quality of the brand. Analy-

* In these mixtures the potash salts are washed out before making the mechanical analysis.

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sis No. 3596 was then made and also No. 3597, given below, from another lot of goods. These two later analyses show tolerable agreement and a considerably better quality than the first analysis. See also analyses of this brand on page 91.

OTHER ANALYSES OF SANDERSON'S FORMULA A.

	3518	3597
Nitrogen as nitrates	1.55	1.95
organic	1.92	2.91
Total nitrogen	3 47	4.86
Phosphoric acid, soluble	5.44	4.99
reverted	3.65	3.57
insoluble	1.55	.68
Total	10.64	9.24
Potash as muriate	5.64	7.43
Chlorine	6.88	6.25
Cost per ton	$35.00	35.00
Valuation per ton	$29.76	34 60

THE GUARANTEES.

The law of Connecticut requires every package of fertilizer to bear a statement of the actual composition of the goods. This usually expresses the quantities of nitrogen, phosphoric acid and potash within certain limits, as "nitrogen 2–4 per cent."

If a fertilizer with such a guarantee actually contains 2 per cent. of nitrogen, it is within the manufacturer's guarantee.

It is the lowest figures of the guarantee therefore that purchasers should regard.

Of the forty-six brands here reported eleven are below their minimum guarantee in respect of one ingredient, and four in respect of two ingredients. That is, one-third of all the nitrogenous superphosphates in our market contain less of one or of two ingredients than they are claimed to contain.

It is urged that an excess of one ingredient over the guarantee should be held to make good the deficiency of another. But with reasonable care and skill in the manufacture and in the sampling and analysis of the goods the actual analysis should not fall below the minimum guaranteed in any respect particularly when wide limits are allowed in the guarantees themselves.

Comparison of the tables of analyses with those of past years shows that certain brands have about the same composition year after year, while others fluctuate considerably and cannot be depended on to be alike year after year.

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Cost and Valuation.

Cost.

The method used to ascertain the retail cash price of the phosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis when done is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

To each manufacturer is also sent a request that he will notify the Station regarding the probable average cash price at freight centers in Connecticut, of such brands as he sells in the State.

From these data the average prices are computed.

Valuation.

The valuation has been computed in all cases in the usual manner.

Percentage Difference given in the last column of the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid and potash contained in the fertilizer.

This information puts the purchaser in a position where he can figure as to the probable relative value of the different brands and the probable relative economy of buying fertilizers mixed or unmixed.

Which method of buying is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

No general rule can be given. In one case ready-mixed, in another, home-mixed fertilizers may be found the more profitable to use.

The average cost of the nitrogenous superphosphates, excluding the last two analyses of the table in which cost exceeds valuation by considerably more than fifty per cent., is $35.28. The average valuation, $25.46, and the percentage difference 27.8.

Last year the corresponding figures were:

Average cost $33.93, Average valuation $28.13, Percentage difference 20.6.

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Nitrogenous Superphosphates and Guanos Sampled by the Station.

Station No.	Name or Brand	Manufacturer.	Dealer.	Dealers' cash price per ton.
3630	Pure Fish Inoculated Bone	Mapes Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Branch, Hartford.	$32.00
3596	Formula A	L. Sanderson, New Haven.	Manufacturer.	35.00
3613	Z. L. Fertilizer	Danbury Fertilizer Co., Danbury	Manufacturer.	30.00
3618	Old Potatoe Superphosphate,	L. Sanderson, New Haven.	E. B. Clark, Milford.	30.00
3627	Complete Manure A Brand	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	City Coal and Wood Co., New Britain.	37.00
			Wilson & Burr, Middletown.	36.00
			Mapes' Branch, Hartford.	35.00
3674	Clarendon's Ammoniated Bone Phosphate	National Fertilizer Co., Bridgeport.	Manufacturer.	30.00
			S. D. Woodruff & Sons, Orange.	32.00
			T. H. Eldridge, Norwich.	34.00
			E. P. Matherson, Pomfret.	33.00
			D. M. Mitchell, South Britain.	32.00
3631	Complete Manure for General Use.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Branch, Hartford.	38.00
			G. K. Nason, Willimantic.	40.00
			City Coal & Wood Co., New Britain.	40.00
3498	Peruvian Guano	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Branch, Hartford.	43.00
3616	Animal Fertilizer,	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Olds & Whipple, Hartford.	38.00
			F. S. Bidwell, Windsor Locks.	36.00
			W. W. Cooper, Suffield.	38.00
3589	Farmers' New Method Fertilizer.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	J. E. Comstock, New London.	33.00
			W. J. Starr, Groton.	34.00
			J. M. Young, Norwich.	30.00
			Wilson & Burr, Middletown.	30.00
			J. A. Lewis, Willimantic.	30.00
			W. F. Andross, East Hartford.	33.00
			S. A. Billings, Meriden.	33.00

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NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3675	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	D. M. Mitchell, South Britain.	$40.00
			T. E. Greene, Torrington.	40.00
			David Fitzgerald, Stratford.	43.00
3600	Sea Fowl Guano.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	33.00
			W. W. Cooper, Suffield.	38.00
3631	Market Garden Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	Meeker Bros., Norwalk.	39.00
			C. A. Young, Danielsonville.	42.00
3638	Ammoniated Bone Phosphate.	Leander Wilcox, Mystic.	Frederic Gallup, New London.	32.25
			J. A. Lewis, Willimantic.	30.00
			H. K. Brainard, Thompsonville.	34.00
			C. M. Smith, East Hartford.	34.00
3524	A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., 215 Pearl St., New York.	W. F. Andross, East Hartford.	37.00
			A. L. Winton, Bridgeport.	37.50
			E. Hawley, Newtown.	37.50
			S. J. Hall, Meriden.	37.50
3605	Original Coe's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Peck Bros., Northfield.	32.00
3613	Standard Phosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	32.00
3530	High Grade Ammoniated Bone Superphosphate.	E. Frank Coe, 16 Burling Slip, New York.	I. W. Denison, Mystic.	32.00
			F. P. Burr, Middletown.	32.00
			J. P. Barstow & Co., Norwich.	32.00
			J. O. Fox & Co., Putnam.	32.00
			Arnold Rudd, New London.	34.00
3637	Bay State Fertilizer.	Clarke Cove Fertilizer Co., Boston, Mass.	H. H. Davenport, Pomfret.	32.00
3678	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport.	T. H. Eldridge, Norwich.	34.00

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NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3525	Hill and Drill Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. H. Larned, Pomfret.	$34.00
			B. Curtis & Son, Stepney.	35 00
			C. H. Bell, Portland.	38.00
			E. M. Brewster, Norwich.	38.00
			C. W. Michael & Co., Yalesville.	38.00
3634	High Grade Farmers' Friend Fertilizer.	Read Fertilizer Co., Box 3121, New York.	C. O. Wolcott, Buckland.	37.50
3577	Ammoniated Bone Fertilizer.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	G. W. Mitchell, South Britain.	30.00
			E. M. Brewster, Norwich.	32.00
			Southington Lumber and Feed Co., Southington.	34.00
3579	Gloucester Fish and Potash.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	W. H. Anderson, Putnam.	28.00
			B. Curtis & Son, Stepney.	30.00
3527	Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	A. C. Sternberg, Hartford.	35.00
			S. A. Billings, Meriden.	37.00
			W. J. Starr, Groton.	37.00
			Wilson & Burr, Middletown.	35 00
			J. M. Young, Norwich.	35.00
			J. A. Lewis, Willimantic.	35.00
			W. F Andross, East Hartford.	35.00
			T. F. Powers, Waterford.	35.00
			Wheeler & Howe, Bridgeport.	37.00
			J. E. Holmes, Stratford.	36.00
3643	High Grade Fish and Potash.	Leander Wilcox, Mystic.	H. K. Brainard, Thompsonville.	32.00
			Frederic Gallup, New London.	31.25
			C. M. Smith, East Hartford.	34.00
			L. C. Gray, Jewett City.	30.00

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NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3543	Quinnipiac Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	J. E. Leonard, Jewett City.	$35.00
			Meeker Bros., Norwalk.	36.00
			C. A. Young, Danielsonville.	35.00
			G. M. Williams & Co., New London.	33.00
3547	Ammoniated Bone Superphosphate.	Crocker Fertilizer Co , Buffalo, N. Y.	C. A. Young, Danielsonville.	35.00
			John Bransfield, Portland.	40.00
			J. E. Leonard, Jewett City.	35.00
			G. W. Clark, Milford.	----
			F. C. Sturtevant, Hartford.	38.00
3578	Sure Crop Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	C. T. Leonard, Norwalk.	30.00
			G. W. Mitchell, South Britain.	25.00
3541	Ammoniated Bone Superphosphate, Americus Brand.	Williams & Clark Fertilizer Co., 83 Fulton St., New York.	H. K. Brainard, Thompsonville.	36.00
			C. E. Stagg, Stratford.	34.00
			D. B. Wilson, Waterbury.	36.00
			F. S. Bidwell, Windsor Locks.	35.00
			Daniel Morgan, Poquonock Bridge.	34.00
			John Bransfield, Portland.	36.00
			W. H. Anderson, Putnam.	35.00
			J. P. Kingsley's Sons, Plainfield.	32.00
			S. D. Woodruff & Sons, Orange.	33.00
3676	Russell Coe's Superphosphate.	National Fertilizer Co., Bridgeport.	T. H. Eldridge, Norwich.	32.00
			Wilson & Burr, Middletown.	30.00
3582	Farm and Garden Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	T. E. Greene, Torrington.	33.00
			D. N. Clark, Shelton.	36.00
3602	Triangle A Fish and Potash.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	29.00
			J. F. Elwood, Southport.	30.00
			G. W. Grant, Wapping.	32.00

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NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Concluded.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3630	Pine Island Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	Olds & Whipple, Hartford.	$35.00
3619	Alkaline Bone Phosphate.	E. Frank Coe, 16 Burling Slip, New York.	H. L. Hall, 2d, Wallingford.	33.00
			C. H. Lounsbury, Seymour.	32.00
3610	Soluble Pacific Guano.	Pacific Guano Co., Box 1368, Boston, Mass.	John Bransfield, Portland.	36.00
			R. H. Tucker, Saybrook.	35.00
			L. J. Grant, Wapping.	35.00
3644	New England Favorite.	J. S. Reese & Co, 10 South St., Baltimore, Md.	Montgomery & Co., Groton.	35.00
3639	Samson Fertilizer.	Read Fertilizer Co., Box 3121, New York.	J. F. Silliman, New Canaan.	38.00
			W. H. Anderson, Putnam.	38.00
			H. W. Morse, Jewett City.	38.00
3608	Fish and Potash, Plain Brand.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	E. J. Dickerman, Mt. Carmel.	34.00
3635	Fish and Potash.	Read Fertilizer Co., Box 3121, New York.	W. Kyle, Bethel.	32.00
			H. W. Morse, Jewett City.	29.00
			C. O. Wolcott, Buckland.	32.00
3611	King Phillip Alkaline Guano.	Clark's Cove Fertilizer Co., Boston, Mass.	H. H. Davenport, Pomfret.	28.00
3617	New Rival Ammoniated Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	W. L. L. Spencer, Lebanon.	32.00
			F. C. Sturtevant, Hartford.	36.00
			E. H. Talcott, Torrington.	32.00
3609	Gold Brand Excelsior Guano.	E. Frank Coe, 16 Burling Slip, New York.	D. N. Clark, Shelton.	42.00
3632	Fish and Potash (Crossed Fishes Brand).	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	Olds & Whipple, Hartford.	36.00
3677	Davidge Special Favorite.	Davidge Fertilizer Co., 121 Front St., New York.	H. S. Benedict, Newtown.	35.00
3633	Standard Fertilizer.	Read Fertilizer Co., Box 3121, New York.	J. F. Silliman, New Canaan.	32.00
			Eli H. Stevens, Brookfield.	32.00
			W. H. Anderson, Putnam.	32.00
			H. W. Morse, Jewett City.	29.00

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Analyses of Nitrogenous Superphosphates and Guanos Sampled by the Station.

Station No.	Name or Brand.	Nitrogen				Phosphoric Acid.							Potash.			Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.	Chlorine.			
3620	Mapes' Pure Fine Dissolved Bone	....	....	3.00	3.00	*2.1*	5.90	10.62	1.13	17.65	*12.0*	16.52	....	....	....	....	$32.00	$33.77	*5.2
3596	†Sanderson's Formula A	1.06	.74	2.44	4.24	*3.3*	3.65	5.03	2.13	10.81	*10.0*	8.68	*6.0*	8.21	*6.0*	4.77	35.00	34.71	.8
3672	Danbury Fertilizer Co's X L Fertilizer	....	....	2.97	2.97	*2.1*	4.12	7.00	.42	11.54	*8.0*	11.12	....	3.30	*3.0*	.58	30.00	29.23	2.6
3512	Sanderson's Old Reliable Superphosphate	....	....	1.82	1.82	*1.7*	11.74	1.12	.38	13.24	*10.0*	12.86	*7.0*	2.65	*2.0*	.20	30.00	28.01	7.1
3627	Mapes' Complete Manure, A Brand	.38	.47	2.06	2.91	*2.5*	9.76	3.31	.30	13.37	*12.0*	13.07	*10.0*	3.11	*2.5*	2.78	36.00	31.57	14.0
3674	Chittenden's Ammoniated Bone Phosphate	trace	....	2.66	2.66	*1.7*	7.20	2.96	1.16	11.32	*9.0*	10.16	*7.0*	2.81	*2.0*	2.52	31.50	26.45	19.1
3621	Mapes' Complete Manure for General Use	.78	.86	1.81	3.45	*3.3*	9.28	1.99	.15	11.42	*10.0*	11.27	*8.0*	4.33	*4.0*	4.20	38.00	31.81	19.4
3498	Mapes' Peruvian Guano	....	1.86	1.15	3.01	*2.5*	2.78	9.30	13.51	25.59	*20.0*	12.08	....	2.77	*3.0*	2.01	43.00	35.27	21.9
3616	Darling's Animal Fertilizer	.17	.57	2.95	3.69	*3.3*	4.32	3.03	2.05	9.40	*10.0*	7.35	....	6.05	*4.0*	3.87	36.00	29.11	23.6
3529	Bradley's Farmers' New Method Fertilizer	....	....	2.34	2.34	*1.7*	6.92	3.02	1.63	11.57	*10.0*	9.94	*8.0*	3.31	*3.0*	3.57	32.00	25.73	24.3
3675	Chittenden's Complete Fertilizer	.23	.31	3.67	4.21	*3.3*	4.05	4.13	1.48	9.66	*8.0*	8.18	*6.0*	6.26	*6.0*	4.69	39.50	31.60	25.0
3600	Bradley's Sea Fowl Guano	....	....	2.73	2.73	*2.5*	7.12	3.01	1.38	11.51	*11.0*	10.13	*9.0*	2.28	*2.0*	1.82	33.00	26.23	25.8
3631	Quinnipiac Market Garden Phosphate	.12	1.13	2.09	3.34	*3.3*	6.98	2.40	.09	9.47	*9.0*	9.38	*8.0*	7.11	*7.0*	3.95	40.00	31.65	26.4
3638	L. Wilcox's Ammoniated Bone Phosphate	.17	.54	2.55	3.26	*2.5*	3.81	3.02	1.60	8.43	*7.0*	6.83	*6.0*	5.02	*5.0*	6.84	32 50	25.67	26.6
3524	Baker's A. A. Ammoniated Superphosphate	.36	1.81	.91	3.08	*2.5*	8.99	2.12	.74	11.85	*11.0*	11.11	*10.0*	2.01	*2.0*	3.35	37.50	29.44	27.4
3605	Bradley's Original Coe's Superphosphate	....	....	2.44	2.44	*1.7*	7.12	2.93	1.82	11.87	*11.0*	10.05	*8.0*	1.96	*1.0*	2.06	32.00	25.08	27.6
3613	Lister's Standard Phosphate	....	.45	2.15	2.60	*1.7*	7.14	2.44	1.97	11.55	*12.0*	9.58	*10.0*	1.81	*1.0*	1.45	32.00	25.01	27.9

* Valuation exceeds cost. † See notice on p. 77.

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Analyses of Nitrogenous Superphosphates and Guanos Sampled by the Station.—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3530	E. F. Coe's High Grade Ammoniated Bone Superphosphate	....	.80	1.44	2.24	*2.0*	7.52	2.25	1.48	11.25	*11.0*	9.77	*9.0*	2.41	*2.0*	.45	$32.00	$24.96	28.2
3687	Clark's Cove Fertilizer Co's Bay State Fertilizer	....	....	2.53	2.53	*2.7*	6.27	3.17	1.97	11.41	*10.0*	9.44	*8.5*	2.45	*2.0*	2.08	32.00	24.95	28 3
3678	Chittenden's Fish and Potash	....	....	3.42	3.42	*3.3*	3.92	2.45	2.00	8.37	*6.0*	6.37	....	5.09	*5.0*	.59	34.00	26.49	28.4
3525	Bowker's Hill and Drill Phosphate	.86	....	1.84	2.70	*2.5*	7.70	3.57	2.55	13.82	*12.0*	11.27	*8.0*	2.10	*2.0*	1.63	36.00	27 93	28.9
3634	Read's High Grade Farmers' Friend Fertilizer	....	.39	2.91	3.30	*3.3*	3.73	2.44	.38	6.55	....	6.17	*5.0*	10.26	*10.0*	9.30	37.50	29.08	29.0
3577	Bowker's Ammoniated Bone Fertilizer	.83	....	1.53	2.36	*2.0*	6.56	3.28	3.03	12.87	*10.0*	9.84	*8 0*	1.88	*2.0*	4.25	32.00	24.71	29.5
3579	Bowker's Gloucester Fish and Potash	.12	....	.84	.96	*.8*	9.34	1.32	3.03	13.69	*9.0*	10.66	*6.0*	1.51	*2.0*	1.99	28.00	21.48	30.3
3527	Bradley's Superphosphate	.12	....	2.75	2.87	*2.3*	7.18	3.15	1.37	11.70	*11.0*	10.33	*9.0*	2.04	*1.5*	2.34	35.00	26.73	30.9
3643	L. Wilcox's High Grade Fish and Potash	....	.27	3.38	3.65	*3.2*	3.10	2.25	.73	6.08	*6.0*	5.35	*5.0*	4 47	*4.0*	7.34	31.50	23.87	31.9
3543	Quinnipiac Phosphate	trace	....	2.82	2.82	*2.5*	6.72	3.34	1.33	11.39	*10.0*	10.06	*9.0*	2.01	*2.0*	2.44	35.00	26.12	34.0
3547	Crocker's Ammoniated Bone Superphosphate	....	....	2.99	2.99	*2.9*	5.47	4.68	2.83	12.98	*11.0*	10.15	*10.0*	1.08	*1.0*	1.58	35.50	26.43	34.3
3578	Bowker's Sure Crop Phosphate	.06	....	.88	.94	....	7.90	2.25	4.14	14.29	....	10.15	....	1.21	....	2.13	28.00	20.75	34.9
3541	Williams & Clark's Bone Superphosphate (Americus Brand)	.07	....	2.62	2.69	*2.5*	7.04	3.21	.96	11.21	*10.0*	10.25	*9.0*	1.95	*2.0*	2.37	35.00	25.85	35.4
3676	National Fertilizer Co's Russell Coe's Superphosphate	....	....	2.07	2.07	*1.6*	3.74	4.40	5.02	13.16	*9.0*	8.14	*8.0*	2.70	*1.0*	2.64	31.00	22.83	35.8

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ANALYSES OF NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Concluded.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3582	Bowker's Farm and Garden Phosphate	.47	....	1.99	2.46	....	6.72	2.07	3.20	11.99	....	8.79	....	2.48	....	4.25	$33.00	$24.27	35.9
3602	Bradley's Triangle A Fish and Potash	....	....	2.62	2.62	*2.0*	4.72	2.38	.73	7.83	*6.0*	7.10	*4.0*	3.72	*4.0*	7.18	31.00	22.43	38.2
3630	Quinnipiac Pine Island Phosphate	....	....	2.46	2.46	*2.1*	5.58	4.07	1.10	10.75	*10.0*	9.65	*9.0*	2.08	*1.0*	2.11	34.00	24.25	40.2
3619	E. F. Coe's Alkaline Bone Phosphate	....	....	1.51	1.51	*.8*	6.56	3.33	3.31	13.20	*9.0*	9.89	*7.0*	1.98	*1.8*	.21	32.00	22.77	40.6
3610	Pacific Guano Co's Soluble Pacific Guano	....	....	2.30	2.30	*2.2*	7.14	2.85	1.64	11.63	*10.5*	9.99	*8.5*	2.34	*2.0*	1.98	35.00	24.83	41.0
3644	Reese's New England Favorite Fertilizer	....	....	2.38	2.38	*2.4*	3.68	6.76	.29	10.73	*11.0*	10.44	*10.0*	2.18	*2.0*	2.85	35.00	24.68	41.8
3639	Read's Samson Fertilizer	.31	....	2.54	2.85	*2.5*	6.83	1.03	.46	8.32	*9.0*	7.86	*8.0*	6.49	*5.0*	5.80	38.00	26.78	41.9
3608	Bowker's Fish and Potash —Plain Brand	....	....	2.17	2.17	*2.2*	6.72	1.12	4.15	11.99	*8.0*	7.84	....	3.73	*4.0*	3.89	34.00	23.61	44.0
3635	Read's Fish and Potash	....	.23	2.54	2.77	*2.5*	3.26	2.08	.29	5.63	*6.0*	5.34	*4.0*	3.42	*4.0*	4.35	29.00	19.94	45.4
3611	Clark's Cove Fertilizer Co's King Philip Alkaline Guano	....	....	1.13	1.13	*1.3*	5.71	2.53	1.53	9.77	*9.0*	8.24	*8.0*	2.45	*3.0*	.23	28.00	18.98	47.5
3617	Crocker's New Rival Ammoniated Phosphate	....	....	1.49	1.49	*1.2*	6.77	2.73	2.51	12.01	*11.0*	9.50	*10.0*	1.60	*1.6*	1.67	32.00	21.19	51.0
3609	E. F. Coe's Gold Brand Excelsior Guano	....	.73	1.41	2.14	*2.5*	6.61	2.04	1.75	10.40	*8.0*	8.65	*6.0*	5.37	*6.0*	.33	40.00	26.37	51.7
3632	Quinnipiac Fish and Potash —Crossed Fishes Brand	....	.43	2.85	3.28	*3.3*	1.79	3.41	2.69	7.89	*5.0*	5.20	*3.0*	3.50	*3.0*	7.43	34.00	22.33	52.2
3677	Davidge Special Favorite Fertilizer	....	....	2.01	2.01	*1.2*	8.48	1.15	.59	10.22	*11.0*	9.63	*10.0*	1.61	*1.5*	1.53	35.00	22.45	55.9
3633	Read's Standard Fertilizer	....	....	1.08	1.08	*.8*	6.90	1.81	.08	8.79	*10.0*	8.71	*8.0*	3.89	*4.0*	4.82	31.00	19.87	56.1
		....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	.....
		....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	.....

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sis No. **3596** was then made and also No. **3597**, given below, from another lot of goods. These two later analyses show tolerable agreement and a considerably better quality than the first analysis. See also analyses of this brand on page 91.

OTHER ANALYSES OF SANDERSON'S FORMULA A.

	3513	3597
Nitrogen as nitrates	1.55	1.95
organic	1.92	2.91
Total nitrogen	3.47	4.86
Phosphoric acid, soluble	5.44	4.99
reverted	3.65	3.57
insoluble	1.55	.68
Total	10.64	9.24
Potash as muriate	5.64	7.43
Chlorine	6.88	6.25
Cost per ton	$35.00	35.00
Valuation per ton	$29.76	34.60

THE GUARANTEES.

The law of Connecticut requires every package of fertilizer to bear a statement of the actual composition of the goods. This usually expresses the quantities of nitrogen, phosphoric acid and potash within certain limits, as "nitrogen 2–4 per cent."

If a fertilizer with such a guarantee actually contains 2 per cent. of nitrogen, it is within the manufacturer's guarantee.

It is the lowest figures of the guarantee therefore that purchasers should regard.

Of the forty-six brands here reported eleven are below their minimum guarantee in respect of one ingredient, and four in respect of two ingredients. That is, one-third of all the nitrogenous superphosphates in our market contain less of one or of two ingredients than they are claimed to contain.

It is urged that an excess of one ingredient over the guarantee should be held to make good the deficiency of another. But with reasonable care and skill in the manufacture and in the sampling and analysis of the goods the actual analysis should not fall below the minimum guaranteed in any respect particularly when wide limits are allowed in the guarantees themselves.

Comparison of the tables of analyses with those of past years shows that certain brands have about the same composition year after year, while others fluctuate considerably and cannot be depended on to be alike year after year.

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Cost and Valuation.

Cost.

The method used to ascertain the retail cash price of the phosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis when done is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

To each manufacturer is also sent a request that he will notify the Station regarding the probable average cash price at freight centers in Connecticut, of such brands as he sells in the State.

From these data the average prices are computed.

Valuation.

The valuation has been computed in all cases in the usual manner.

Percentage Difference given in the last column of the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid and potash contained in the fertilizer.

This information puts the purchaser in a position where he can figure as to the probable relative value of the different brands and the probable relative economy of buying fertilizers mixed or unmixed.

Which method of buying is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

No general rule can be given. In one case ready-mixed, in another, home-mixed fertilizers may be found the more profitable to use.

The average cost of the nitrogenous superphosphates, excluding the last two analyses of the table in which cost exceeds valuation by considerably more than fifty per cent., is $35.28. The average valuation, $25.46, and the percentage difference 27.8.

Last year the corresponding figures were:

Average cost $33.93, Average valuation $28.13, Percentage difference 20.6.

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sis No. **3596** was then made and also No. **3597**, given below, from another lot of goods. These two later analyses show tolerable agreement and a considerably better quality than the first analysis. See also analyses of this brand on page 91.

OTHER ANALYSES OF SANDERSON'S FORMULA A.

	3513	3597
Nitrogen as nitrates	1.55	1.95
organic	1.92	2.91
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Phosphoric acid, soluble	5.44	4.99
reverted	3.65	3.57
insoluble	1.55	.68
Total	10.64	9.24
Potash as muriate	5.64	7.43
Chlorine	6.88	6.25
Cost per ton	$35.00	35.00
Valuation per ton	$29.76	34.60

THE GUARANTEES.

The law of Connecticut requires every package of fertilizer to bear a statement of the actual composition of the goods. This usually expresses the quantities of nitrogen, phosphoric acid and potash within certain limits, as "nitrogen 2–4 per cent."

If a fertilizer with such a guarantee actually contains 2 per cent. of nitrogen, it is within the manufacturer's guarantee.

It is the lowest figures of the guarantee therefore that purchasers should regard.

Of the forty-six brands here reported eleven are below their minimum guarantee in respect of one ingredient, and four in respect of two ingredients. That is, one-third of all the nitrogenous superphosphates in our market contain less of one or of two ingredients than they are claimed to contain.

It is urged that an excess of one ingredient over the guarantee should be held to make good the deficiency of another. But with reasonable care and skill in the manufacture and in the sampling and analysis of the goods the actual analysis should not fall below the minimum guaranteed in any respect particularly when wide limits are allowed in the guarantees themselves.

Comparison of the tables of analyses with those of past years shows that certain brands have about the same composition year after year, while others fluctuate considerably and cannot be depended on to be alike year after year.

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Cost and Valuation.

Cost.

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The sampling agents inquire and note the price at the time each sample is drawn. The analysis when done is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

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From these data the average prices are computed.

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Which method of buying is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

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Last year the corresponding figures were:

Average cost $33.93, Average valuation $28.13, Percentage difference 20.6.

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Nitrogenous Superphosphates and Guanos Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3620	Pure Fine Dissolved Bone.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Branch, Hartford.	$32.00
3596	Formula A.	L. Sanderson, New Haven.	Manufacturer.	35.00
3672	X L Fertilizer.	Danbury Fertilizer Co., Danbury.	Manufacturer.	30.00
3512	Old Reliable Superphosphate.	L. Sanderson, New Haven.	E B. Clark, Milford.	30.00
3627	Complete Manure, A Brand.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	City Coal and Wood Co., New Britain.	37.00
			Wilson & Burr, Middletown.	36.00
			Mapes' Branch, Hartford.	35.00
3674	Chittenden's Ammoniated Bone Phosphate.	National Fertilizer Co., Bridgeport.	Manufacturer.	30.00
			S. D. Woodruff & Sons, Orange.	32.00
			T. H. Eldridge, Norwich.	34.00
			E. P. Matherson, Pomfret.	33.00
			D. M. Mitchell, South Britain.	32.00
3621	Complete Manure for General Use.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Branch, Hartford.	38.00
			G. K. Nason, Willimantic.	40.00
			City Coal & Wood Co., New Britain.	40.00
3498	Peruvian Guano.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes' Branch, Hartford.	43.00
3616	Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Olds & Whipple, Hartford.	38.00
			F. S. Bidwell, Windsor Locks.	36.00
			W W. Cooper, Suffield.	38.00
3529	Farmers' New Method Fertilizer.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	J. E. Comstock, New London.	33.00
			W. J. Starr, Groton.	34.00
			J. M. Young, Norwich.	30.00
			Wilson & Burr, Middletown.	30.00
			J. A. Lewis, Willimantic.	30.00
			W. F. Andross, East Hartford.	33.00
			S. A. Billings, Meriden.	33.00

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NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3675	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	D. M. Mitchell, South Britain.	$40.00
			T. E. Greene, Torrington.	40.00
			David Fitzgerald, Stratford.	43.00
3600	Sea Fowl Guano.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	33.00
			W. W. Cooper, Suffield.	38.00
3631	Market Garden Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	Meeker Bros., Norwalk.	39.00
			C. A. Young, Danielsonville.	42.00
3688	Ammoniated Bone Phosphate.	Leander Wilcox, Mystic.	Frederic Gallup, New London.	32.25
			J. A. Lewis, Willimantic.	30.00
			H. K. Brainard, Thompsonville.	34.00
			C. M. Smith, East Hartford.	34.00
3524	A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., 215 Pearl St., New York.	W. F. Andross, East Hartford.	37.00
			A. L. Winton, Bridgeport.	37.50
			E. Hawley, Newtown.	37.50
			S. J. Hall, Meriden.	37.50
3605	Original Coe's Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	Peck Bros., Northfield.	32.00
3613	Standard Phosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	32.00
3530	High Grade Ammoniated Bone Superphosphate.	E. Frank Coe, 16 Burling Slip, New York.	I. W. Denison, Mystic.	32.00
			F. P. Burr, Middletown.	32.00
			J. P. Barstow & Co., Norwich.	32.00
			J. O. Fox & Co., Putnam.	32.00
			Arnold Rudd, New London.	34.00
3637	Bay State Fertilizer.	Clarke Cove Fertilizer Co., Boston, Mass.	H. H. Davenport, Pomfret.	32.00
3678	Chittenden's Fish and Potash.	National Fertilizer Co., Bridgeport.	T. H. Eldridge, Norwich.	34.00

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NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3525	Hill and Drill Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. H. Larned, Pomfret.	$34.00
			B. Curtis & Son, Stepney.	35 00
			C. H. Bell, Portland.	38.00
			E. M. Brewster, Norwich.	38.00
			C. W. Michael & Co., Yalesville.	38.00
3634	High Grade Farmers' Friend Fertilizer.	Read Fertilizer Co., Box 3121, New York.	C. O. Wolcott, Buckland.	37.50
3577	Ammoniated Bone Fertilizer.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	G. W. Mitchell, South Britain.	30.00
			E. M. Brewster, Norwich.	32.00
			Southington Lumber and Feed Co., Southington.	34.00
3579	Gloucester Fish and Potash.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	W. H. Anderson, Putnam.	28.00
			B. Curtis & Son, Stepney.	30.00
3527	Superphosphate.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	A. C. Sternberg, Hartford.	35.00
			S. A. Billings, Meriden.	37.00
			W. J. Starr, Groton.	37.00
			Wilson & Burr, Middletown.	35 00
			J. M. Young, Norwich.	35.00
			J. A. Lewis, Willimantic.	35.00
			W. F Andross, East Hartford.	35.00
			T. F. Powers, Waterford.	35.00
			Wheeler & Howe, Bridgeport.	37.00
			J. E. Holmes, Stratford.	36.00
3643	High Grade Fish and Potash.	Leander Wilcox, Mystic.	H. K. Brainard, Thompsonville.	32.00
			Frederic Gallup, New London.	31.25
			C. M. Smith, East Hartford.	34.00
			L. C. Gray, Jewett City.	30.00

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NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3543	Quinnipiac Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	J. E. Leonard, Jewett City.	$35.00
			Meeker Bros., Norwalk.	36.00
			C. A. Young, Danielsonville.	35.00
			G. M. Williams & Co., New London.	33.00
3547	Ammoniated Bone Superphosphate.	Crocker Fertilizer Co , Buffalo, N. Y.	C. A. Young, Danielsonville.	35.00
			John Bransfield, Portland.	40.00
			J. E. Leonard, Jewett City.	35.00
			G. W. Clark, Milford.	----
			F. C. Sturtevant, Hartford.	38.00
3578	Sure Crop Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	C. T. Leonard, Norwalk.	30.00
			G. W. Mitchell, South Britain.	25.00
3541	Ammoniated Bone Superphosphate, Americus Brand.	Williams & Clark Fertilizer Co., 83 Fulton St., New York.	H. K. Brainard, Thompsonville.	36.00
			C. E. Stagg, Stratford.	34.00
			D. B. Wilson, Waterbury.	36.00
			F. S. Bidwell, Windsor Locks.	35.00
			Daniel Morgan, Poquonock Bridge.	34.00
			John Bransfield, Portland.	36.00
			W. H. Anderson, Putnam.	35.00
			J. P. Kingsley's Sons, Plainfield.	32.00
			S. D. Woodruff & Sons, Orange.	33.00
3676	Russell Coe's Superphosphate.	National Fertilizer Co., Bridgeport.	T. H. Eldridge, Norwich.	32.00
			Wilson & Burr, Middletown.	30.00
3582	Farm and Garden Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	T. E. Greene, Torrington.	33.00
			D. N. Clark, Shelton.	36.00
3602	Triangle A Fish and Potash.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	29.00
			J. F. Elwood, Southport.	30.00
			G. W. Grant, Wapping.	32.00

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NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Concluded.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3630	Pine Island Phosphate.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	Olds & Whipple, Hartford.	$35.00
3619	Alkaline Bone Phosphate.	E. Frank Coe, 16 Burling Slip, New York.	H. L. Hall, 2d, Wallingford.	33.00
			C. H. Lounsbury, Seymour.	32.00
3610	Soluble Pacific Guano.	Pacific Guano Co., Box 1368, Boston, Mass.	John Bransfield, Portland.	36.00
			R. H. Tucker, Saybrook.	35.00
			L. J. Grant, Wapping.	35.00
3644	New England Favorite.	J. S. Reese & Co , 10 South St., Baltimore, Md.	Montgomery & Co., Groton.	35.00
3639	Samson Fertilizer.	Read Fertilizer Co., Box 3121, New York.	J. F. Silliman, New Canaan.	38.00
			W. H. Anderson, Putnam.	38.00
			H. W. Morse, Jewett City.	38.00
3608	Fish and Potash, Plain Brand.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	E. J. Dickerman, Mt. Carmel.	34.00
3635	Fish and Potash.	Read Fertilizer Co., Box 3121, New York.	W. Kyle, Bethel.	32.00
			H. W. Morse, Jewett City.	29.00
			C. O. Wolcott, Buckland.	32.00
3611	King Phillip Alkaline Guano.	Clark's Cove Fertilizer Co., Boston, Mass.	H. H. Davenport, Pomfret.	28.00
3617	New Rival Ammoniated Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	W. L. L. Spencer, Lebanon.	32.00
			F. C. Sturtevant, Hartford.	36.00
			E. H. Talcott, Torrington.	32.00
3609	Gold Brand Excelsior Guano.	E. Frank Coe, 16 Burling Slip, New York.	D. N. Clark, Shelton.	42.00
3632	Fish and Potash (Crossed Fishes Brand).	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	Olds & Whipple, Hartford.	36.00
3677	Davidge Special Favorite.	Davidge Fertilizer Co., 121 Front St., New York.	H. S. Benedict, Newtown.	35.00
3633	Standard Fertilizer.	Read Fertilizer Co., Box 3121, New York.	J. F. Silliman, New Canaan.	32.00
			Eli H. Stevens, Brookfield.	32.00
			W. H. Anderson, Putnam.	32.00
			H. W. Morse, Jewett City.	29.00

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Analyses of Nitrogenous Superphosphates and Guanos Sampled by the Station.

Station No.	Name or Brand.	Nitrogen.				Phosphoric Acid.							Potash.			Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.	Chlorine.			
3620	Mapes' Pure Fine Dissolved Bone	....	....	3.00	3.00	*2.1*	5.90	10.62	1.13	17.65	*12.0*	16.52	....	....	....	....	$32.00	$33.77	*5.2
3596	†Sanderson's Formula A	1.06	.74	2.44	4.24	*3.3*	3 65	5.03	2.13	10.81	*10.0*	8.68	*6.0*	8.21	*6.0*	4.77	35.00	34.71	.8
3672	Danbury Fertilizer Co's X L Fertilizer	.. .	....	2.97	2.97	*2.1*	4.12	7.00	.42	11.54	*8.0*	11.12	....	3.30	*3.0*	.58	30.00	29.23	2.6
3512	Sanderson's Old Reliable Superphosphate	....	....	1.82	1.82	*1.7*	11.74	1.12	.38	13.24	*10.0*	12 86	*7.0*	2.65	*2.0*	.20	30.00	28.01	7.1
3627	Mapes' Complete Manure, A Brand	.38	.47	2.06	2.91	*2.5*	9.76	3.31	.30	13.37	*12.0*	13.07	*10.0*	3.11	*2.5*	2.78	36.00	31.57	14.0
3674	Chittenden's Ammoniated Bone Phosphate	trace	....	2.66	2 66	*1.7*	7.20	2.96	1.16	11.32	*9.0*	10.16	*7.0*	2.81	*2.0*	2.52	31.50	26.45	19.1
3621	Mapes' Complete Manure for General Use	.78	.86	1.81	3.45	*3.3*	9.28	1.99	.15	11.42	*10.0*	11.27	*8.0*	4.33	*4.0*	4.20	38.00	31.81	19.4
3498	Mapes' Peruvian Guano	....	1.86	1.15	3.01	*2.5*	2.78	9.30	13.51	25.59	*20.0*	12.08	....	2.77	*3.0*	2.01	43.00	35.27	21.9
3616	Darling's Animal Fertilizer	.17	.57	2.95	3.69	*3.3*	4.32	3.03	2.05	9.40	*10.0*	7.35	....	6.05	*4.0*	3.87	36.00	29.11	23.6
3529	Bradley's Farmers' New Method Fertilizer	....	....	2.34	2.34	*1.7*	6.92	3.02	1.63	11.57	*10.0*	9.94	*8.0*	3.31	*3.0*	3.57	32.00	25.73	24.3
3675	Chittenden's Complete Fertilizer	.23	.31	3.67	4.21	*3.3*	4.05	4.13	1.48	9.66	*8.0*	8.18	*6.0*	6.26	*6.0*	4.69	39.50	31.60	25.0
3600	Bradley's Sea Fowl Guano	....	....	2.73	2.73	*2.5*	7.12	3.01	1.38	11.51	*11.0*	10.13	*9.0*	2.28	*2.0*	1.82	33.00	26.23	25.8
3631	Quinnipiac Market Garden Phosphate	.12	1.13	2.09	3.34	*3.3*	6.98	2.40	.09	9.47	*9.0*	9.38	*8.0*	7.11	*7.0*	3.95	40.00	31.65	26.4
3688	L. Wilcox's Ammoniated Bone Phosphate	.17	.54	2.55	3.26	*2.5*	3.81	3.02	1.60	8.43	*7.0*	6.83	*6.0*	5.02	*5.0*	6.84	32.50	25.67	26.6
3524	Baker's A. A. Ammoniated Superphosphate	.36	1.81	.91	3.08	*2.5*	8.99	2.12	.74	11.85	*11.0*	11.11	*10.0*	2.01	*2.0*	3.35	37.50	29.44	27.4
3605	Bradley's Original Coe's Superphosphate	....	....	2.44	2.44	*1.7*	7.12	2.93	1.82	11.87	*11.0*	10.05	*8.0*	1.96	*1.0*	2.06	32.00	25.08	27.6
3618	Lister's Standard Phosphate	....	.45	2.15	2.60	*1.7*	7.14	2.44	1.97	11.55	*12.0*	9.58	*10.0*	1.81	*1.0*	1.45	32.00	25.01	27.9

* Valuation exceeds cost. † See notice on p. 77.

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Analyses of Nitrogenous Superphosphates and Guanos Sampled by the Station.—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3530	E. F. Coe's High Grade Ammoniated Bone Superphosphate	....	.80	1.44	2.24	*2.0*	7.52	2.25	1.48	11.25	*11.0*	9.77	*9.0*	2.41	*2.0*	.45	$32.00	$24.96	28.2
3687	Clark's Cove Fertilizer Co's Bay State Fertilizer	....	....	2.53	2.53	*2.7*	6.27	3.17	1.97	11.41	*10.0*	9.44	*8.5*	2.45	*2.0*	2.08	32.00	24.95	28 3
3678	Chittenden's Fish and Potash	....	....	3.42	3.42	*3.3*	3.92	2.45	2.00	8.37	*6.0*	6.37	....	5.09	*5.0*	.59	34.00	26.49	28.4
3525	Bowker's Hill and Drill Phosphate	.86	....	1.84	2.70	*2.5*	7.70	3.57	2.55	13.82	*12.0*	11.27	*8.0*	2.10	*2.0*	1.63	36.00	27 93	28.9
3684	Read's High Grade Farmers' Friend Fertilizer	....	.39	2.91	3.30	*3.3*	3.73	2.44	.38	6.55	....	6.17	*5.0*	10.26	*10.0*	9.30	37.50	29.08	29.0
3577	Bowker's Ammoniated Bone Fertilizer	.83	....	1.53	2.36	*2.0*	6.56	3.28	3.03	12.87	*10.0*	9.84	*8.0*	1.88	*2.0*	4.25	32.00	24.71	29.5
3579	Bowker's Gloucester Fish and Potash	.12	....	.84	.96	*.8*	9.34	1.32	3.03	13.69	*9.0*	10.66	*6.0*	1.51	*2.0*	1.99	28.00	21.48	30.3
3527	Bradley's Superphosphate	.12	....	2.75	2.87	*2.3*	7.18	3.15	1.37	11.70	*11.0*	10.33	*9.0*	2.04	*1.5*	2.34	35.00	26.73	30.9
3643	L. Wilcox's High Grade Fish and Potash	....	.27	3.38	3.65	*3.2*	3.10	2.25	.73	6.08	*6.0*	5.35	*5.0*	4 47	*4.0*	7.34	31.50	23.87	31.9
3543	Quinnipiac Phosphate	trace	....	2.82	2.82	*2.5*	6.72	3.34	1.33	11.39	*10.0*	10.06	*9.0*	2.01	*2.0*	2.44	35.00	26.12	34.0
3547	Crocker's Ammoniated Bone Superphosphate	....	....	2.99	2.99	*2.9*	5.47	4.68	2.83	12.98	*11.0*	10.15	*10.0*	1.08	*1.0*	1.58	35.50	26.43	34.3
3578	Bowker's Sure Crop Phosphate	.06	....	.88	.94	....	7.90	2.25	4.14	14.29	....	10.15	....	1.21	....	2.13	28.00	20.75	34.9
3541	Williams & Clark's Bone Superphosphate (Americus Brand)	.07	....	2.62	2.69	*2.5*	7.04	3.21	.96	11.21	*10.0*	10.25	*9.0*	1.95	*2.0*	2.37	35.00	25.85	35.4
3676	National Fertilizer Co's Russell Coe's Superphosphate	....	....	2.07	2.07	*1.6*	3.74	4.40	5.02	13.16	*9.0*	8.14	*8.0*	2.70	*1.0*	2.64	31.00	22.83	35.8

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Analyses of Nitrogenous Superphosphates and Guanos Sampled by the Station.—*Concluded.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3582	Bowker's Farm and Garden Phosphate	.47	....	1.99	2.46	....	6.72	2.07	3.20	11.99	....	8.79	....	2.48	....	4.25	$33.00	$24.27	35.9
3602	Bradley's Triangle A Fish and Potash	....	....	2.62	2.62	*2.0*	4.72	2.38	.73	7.83	*6.0*	7.10	*4.0*	3.72	*4.0*	7.18	31.00	22.43	38.2
3630	Quinnipiac Pine Island Phosphate	....	....	2.46	2.46	*2.1*	5.58	4.07	1.10	10.75	*10.0*	9.65	*9.0*	2.08	*1.0*	2.11	34.00	24.25	40.2
3619	E. F. Coe's Alkaline Bone Phosphate	....	....	1.51	1.51	*.8*	6.56	3.33	3.31	13.20	*9.0*	9.89	*7 0*	1.98	*1.8*	.21	32.00	22.77	40.6
3610	Pacific Guano Co's Soluble Pacific Guano	....	....	2.30	2.30	*2.2*	7.14	2.85	1.64	11.63	*10.5*	9.99	*8 5*	2.34	*2 0*	1.98	35.00	24.83	41.0
3644	Reese's New England Favorite Fertilizer	....	....	2.38	2.38	*2.4*	3.68	6.76	.29	10.73	*11.0*	10.44	*10.0*	2.18	*2.0*	2.85	35.00	24.68	41.8
3639	Read's Samson Fertilizer	.31	....	2.54	2.85	*2.5*	6.83	1.03	.46	8.32	*9.0*	7.86	*8.0*	6.49	*5.0*	5.80	38.00	26.78	41.9
3608	Bowker's Fish and Potash —Plain Brand	....	....	2.17	2.17	*2.2*	6.72	1.12	4.15	11.99	*8.0*	7.84	....	3.73	*4.0*	3.89	34.00	23.61	44.0
3635	Read's Fish and Potash	....	.23	2.54	2.77	*2.5*	3.26	2.08	.29	5.63	*6 0*	5.34	*4.0*	3.42	*4.0*	4.35	29.00	19.94	45.4
3611	Clark's Cove Fertilizer Co's King Philip Alkaline Guano	....	....	1.13	1.13	*1.3*	5.71	2.53	1.53	9.77	*9.0*	8.24	*8.0*	2.45	*3.0*	.23	28.00	18.98	47.5
3617	Crocker's New Rival Ammoniated Phosphate	....	....	1.49	1.49	*1.2*	6.77	2.73	2.51	12.01	*11.0*	9.50	*10.0*	1.60	*1.6*	1.67	32.00	21.19	51.0
3609	E. F. Coe's Gold Brand Excelsior Guano	....	.73	1.41	2.14	*2.5*	6.61	2.04	1.75	10.40	*8.0*	8.65	*6.0*	5.37	*6.0*	.33	40.00	26.37	51.7
3632	Quinnipiac Fish and Potash —Crossed Fishes Brand	....	.43	2.85	3.28	*3.3*	1.79	3.41	2.69	7.89	*5 0*	5.20	*3.0*	3.50	*3.0*	7.43	34.00	22.33	52.2
3677	Davidge Special Favorite Fertilizer	....	....	2.01	2.01	*1.2*	8.48	1.15	.59	10.22	*11.0*	9.63	*10.0*	1.61	*1.5*	1.53	35.00	22.45	55.9
3633	Read's Standard Fertilizer	....	....	1.08	1.08	*.8*	6.90	1.81	.08	8.79	*10.0*	8.71	*8.0*	3.89	*4.0*	4.82	31.00	19.87	56.1

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Fish and Potash.—Sampled by the Station.

	Chittenden's.	Bowker's Gloucester.	Wilcox's.	Bradley's* Triangle A.	Bowker's Plain Brand.	Read's.	Quinnipiac Crossed Fishes.
	3678	3579	3643	3602	3608	3635	3632
Nitrogen as Ammonia	----	----	.27	----	----	.23	.43
Nitrogen, Organic	3.42	.84	3.38	2.62	2.17	2.54	2.85
Soluble Phosphoric Acid	3.92	9.34	3.10	4.72	6.72	3.26	1.79
Reverted Phosphoric Acid	2.45	1.32	2.25	2.38	1.12	2.08	3.41
Insoluble Phosphoric Acid	2.00	3.03	.73	.73	4.15	.29	2.69
Potash	5.09	1.51	4.47	3.72	3.73	3.42	3.50
Cost	$34.00	$28.00	$31.50	$31.00	$34.00	$29.00	$34.00
Valuation	26.49	21.48	23.87	22.43	23.61	19.94	22.33

* See also analysis of Bradley's Anchor Brand manufacturer's sample on page 91.

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Fish and Potash.

The samples of Fish and Potash included in the previous tables are tabulated by themselves for comparison on page 88.

2. *Sampled by Manufacturers and* 3. *Sampled by private individuals.*

(For tabulated analyses see page 91).

2. *Sampled by Manufacturers.*

These samples were sent to the Station in compliance with the terms of the Fertilizer Law and were analyzed because no samples of the brands named were found in market by our sampling agents:

3598. Fish and Potash, Anchor Brand, made by Bradley Fertilizer Co., Boston, Mass.

3647. Buffalo Superphosphate, No. 2, made by Crocker Fertilizer Co., Buffalo, N. Y.

3651. Vegetable Bone Superphosphate, made by Crocker Fertilizer Co., Buffalo, N. Y.

3652. Ammoniated Practical Superphosphate, made by Crocker Fertilizer Co., Buffalo, N. Y.

3650. Garden and Lawn Fertilizer, made by L. B. Darling Fertilizer Co., Pawtucket, R. I.

3654. Success Phosphate, made by Lister's Agricultural Chemical Works, Newark, N. J.

3655. Ammoniated Dissolved Bone, made by Lister's Agricultural Chemical Works, Newark, N. J.

3656. Ammoniated Bone Superphosphate, made by Preston Fertilizer Co., Greenpoint, L. I.

3653. Pilgrim Fertilizer, made by J. S. Reese & Co., Baltimore, Md.

3. *Sampled by private individuals.*

The following analyses were made on samples submitted by private individuals.

3521. Bone Fish and Potash, made by E. R. Kelsey, Branford. Sampled and sent by E. C. Warner, Fair Haven.

3681. Fertilizer made for Conn. Valley Orchard Co., by the Quinnipiac Co., N. Y. Sampled by D. L. Rogers, New Britain.

3537. Formula A, made by L. Sanderson, New Haven. Sampled by F. R. Curtiss, Stratford.

3698. Formula A, made by L. Sanderson, in the fall of 1892.

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3699. Formula A, made by L. Sanderson, in the spring of 1892.

The last two samples were drawn by F. H. Todd, North Haven.

III. Special Manures.

1. *Sampled by Station Agents.*

For Analyses and Valuations see pages 93 *to* 100.

Here are included such Nitrogenous Superphosphates as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

Notice of Particular Analyses.

Fairchild's Formula for Corn and General Crops No. **3507** is a mixture of nitrate of soda, muriate of potash and fine bone flour, 90 per cent. of which passes a round mesh $\frac{1}{16}$ inch in diameter.

An analysis **3534** was made of 6 samples of the Quinnipiac Potato Manure with the results given below. The manufacturer protested against the analysis because it did not represent the average quality of the goods which should show a much higher per cent. of potash than was indicated in this analysis. The Station, therefore, determined potash separately in each of the samples with the following results:

From Taylor & Hubbell, Newtown	1.79 per cent.
D. C. Wood	5.66 "
Olds & Whipple	5.39 "
W. L. L. Spencer	5.41 "
C. A. Young	5.24 "
G. M. Williams	4.69 "

It is evident that the sample from Taylor & Hubbell is totally unlike the others. A new mixture of samples was, therefore, prepared from which this sample low in potash was excluded. The analysis of this second sample, No. **3684**, is given in the table on page 100.

	3534
Nitrogen, organic	2.71
Phosphoric acid, soluble	5.52
reverted	2.74
insoluble	.75
Total	9.01
Potash	4.65
Chlorine	3.41

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NITROGENOUS SUPERPHOSPHATES—SAMPLED BY MANUFACTURERS AND BY PRIVATE INDIVIDUALS—ANALYSES AND VALUATIONS.

	3598	3647	3651	3652	3650	3654	3655	3656	3658	3521	3681	3587	3698	3699
Nitrogen as nitrates	....	....	....	....	.98	....	....	....	....	....	.71	....	....	1.36
as ammonia	....	....	....	....	.23	.27	.47	.39	.31	.66	....	....	....	....
organic	3.85	....	5.70	.82	2.51	1.58	1.72	2.09	1.25	3.34	1.98	....	.89	2.16
Total nitrogen found	3.85	....	5.70	.82	3.72	1.85	2.19	2.48	1.56	4.00	2.69	3.54	.89	3.52
NITROGEN GUARANTEED	**2.2**	....	**5.0**	**.82**	....	**1.0**	**1.8**	**2.3**	**1.0**	**3.3**	....	**3.3**	**3.3**	**3.3**
Phosphoric acid, soluble	3.55	10.80	6.35	5.63	4.80	6.38	5.89	4 90	1.68	2.88	6.83	....	14.16	7.10
reverted	2.90	1.43	.73	3.41	3.52	2.92	3.49	4.21	7.89	2.09	3.96	....	1.01	3.57
insoluble	1.70	.95	.75	1.64	2.00	2.85	2.07	2.24	1.65	.26	1.34	....	.22	.96
Total phosphoric acid found	8.15	13.18	7.83	10.68	10.32	12.15	11.45	11.35	11.22	5.23	12.13	9.79	15.39	11.63
PHOSPHORIC ACID GUARANTEED	**5.0**	**12.0**	**7.0**	**9.0**	....	....	**11.0**	....	**7.5**	**4.0**	....	**10.0**	**10.0**	**10.0**
Available phosphoric acid found	6.45	12.23	7.08	9.04	8.32	9.30	9.38	9.11	9.57	4.97	10.79	....	15.17	10.67
AVAILABLE PHOSPHORIC ACID GUAR.	**3.0**	**11.0**	**6.0**	**8.0**	....	**10.5**	**9.0**	**9.0**	**6.5**	....	....	**6.0**	**6.0**	**6.0**
Potash	3.84	2.16	6.73	2.17	6.97	1.98	1.89	3.83	2.25	2.83	2.81	7.97	6.37	6.75
POTASH GUARANTEED	**3.0**	**1.35**	**6.0**	**1.0**	....	**1.5**	**1.5**	**2.0**	....	**3.0**	....	**6.0**	**6.0**	**6.0**
Chlorine	1.98	1.95	6.06	2.05	5.61	1.58	1.72	2.08	3.00	.43	2.71	....	6.06	5.48
Valuation	$26.09	20.52	35.15	18.45	30.98	22.59	23.41	25.85	21.34	23.35	27.34	....	31.32	33.10

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Guarantees.

Of the thirty-nine brands of special manures analyzed, sixteen are below the manufacturer's minimum guarantee in respect of one ingredient, and one is below in respect of two ingredients.

Cost, Valuation and Percentage Difference.

The average cost per ton of the special manures has been $38.28, the average valuation $30.70, and the percentage difference 25.0, a little higher than in case of the nitrogenous superphosphates.

Last year the corresponding figures were: Average cost $38.84, average valuation $31.64, percentage difference 22.8.

2. *Sampled by Manufacturers, and* 3. *Sampled by Private Individuals.*

2. *Manufacturers' Samples.*

These samples were sent to the Station in compliance with the terms of the Fertilizer Law and were analyzed because no samples of the brands named were found in market by our sampling agents.

3599. Complete Manure for Grass and Grain, made by the Bradley Fertilizer Co., Boston, Mass.

3649. Potato and Root Crop Manure, made by Darling Fertilizer Co., Pawtucket, R. I.

3. *Samples drawn by Private Individuals.*

3687. Mapes' Tobacco Manure, Wrapper Brand, from stock of W. H. Filley, Windsor. Sampled by O. P. Parsons, Poquonock.

3688. Fine Wrapper Brand Tobacco Grower, made by Williams and Clark Fertilizer Co., N. Y. Stock of I. J. Beardsley, New Preston. Sampled by G. B. Ackley.

Analyses and Valuations.

	3599	3649	3687	3688
Nitrogen as nitrates	5.99	.37	1.51	....
as ammonia	....	.23	3.20	2.64
organic	....	2.94	1.67	3.33
Total Nitrogen	**5.99**	**3.54**	**6.38**	**5.97**
Phosphoric acid, soluble	2.72	4.16	.61	.18
reverted	3.70	3.79	3.08	5.49
insoluble	1.60	2.69	2.50	5.60
Total Phosphoric Acid	**8.02**	**10.64**	**6.19**	**11.27**
Potash as muriate	.36	6.78	.90	1.06
as sulphate	2.98	....	10.44	9.58
Total Potash	**3.34**	**6.78**	**11.34**	**10.64**
Chlorine	.27	7.13	.68	.79
Valuation	$31.46	30.05	39.60	41.60

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Special Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3507	Fairchild's Formula for Corn and General Crops.	Rogers & Hubbard Co., Middletown.	Daniel Moriarty, South Meriden.	$18.00
			Manufacturer.	
3671	Tobacco Fertilizer.	Danbury Fertilizer Co., Danbury.	Manufacturer.	35.00
3672	Potato Manure.	Danbury Fertilizer Co., Danbury.	J. B. Beers, Brookfield.	30.00
			Manufacturer.	35.00
3629	Manure for Seeding Down.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes Branch, Hartford.	37.50
3625	Manure for Fruit and Vines.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	Mapes Branch, Hartford.	38.00
3626	Tobacco Starter.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St, New York.	Southington Lumber & Feed Co., Southington.	36.00
			F. S. Bidwell, Windsor Locks.	37.00
			Wilson & Burr, Middletown.	36.00
			Mapes Branch, Hartford.	36.00
3576	Corn Manure.	H. J. Baker & Bro., 215 Pearl St., New York.	C. O. Jelliff & Co., Southport.	38.00
3545	Manure for Light Soil.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	G. K. Nason, Willimantic.	43.00
			Raymond Bros., South Norwalk.	42.00
			Mapes Branch, Hartford.	42.00
			Wilson & Burr, Middletown.	43.00
			J. P. Barstow & Co, Norwich.	42.00
3508	Soluble Potato Manure.	The Rogers & Hubbard Co., Middletown.	Daniel Moriarty, South Meriden.	39.00
			Manufacturer.	38.00
3585	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	J. E. Holmes, Stratford.	39.00
			Peck Bros., Northfield.	40.00
3526	Grass and Grain Spring Top Dressing.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	J. P. Barstow & Co., Norwich.	40.00
			G. K. Nason, Willimantic.	41.00
			Wilson & Burr, Middletown.	40.00
			Mapes Branch, Hartford.	39.00

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SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3575	Complete Tobacco Manure.	H. J. Baker & Bro., 215 Pearl St., New York.	H. K. Brainard, Thompsonville.	$40.00
			E. Hawley, Newtown.	42.50
			F. S. Bidwell, Windsor Locks.	41.50
			W. F. Andross, East Hartford.	42.00
3640	Potato, Onion and Tobacco Fertilizer.	Leander Wilcox, Mystic.	L. C. Gray, Jewett City.	33.00
			Frederic Gallup, New London.	34.25
			J. A. Lewis, Willimantic.	32.00
			C. M. Smith, East Hartford.	36.00
3646	Havana and Seed Leaf Tobacco Fertilizer.	Quinnipiac Co, 7 Exchange Place, Boston, Mass.	Olds & Whipple, Hartford.	50.00
3544	Manure for Corn.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	F. S. Bidwell, Windsor Locks.	40.00
			G. K. Nason, Willimantic.	40.00
			J. H. Ray & Son, Greenwich.	43.00
			Mapes Branch, Hartford.	39.00
			J. P. Barstow & Co., Norwich.	40.00
			C. W. Beardsley, Milford.	42.00
3584	Stockbridge Top Dressing.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	
3628	Tobacco Manure—Wrapper Brand.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St, New York.	Southington Lumber & Feed Co, Southington.	47.50
			F. S. Bidwell, Windsor Locks.	49.00
			Mapes Branch, Hartford.	48.00
3603	High Grade Tobacco Manure.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	F. S. Bidwell, Windsor Locks.	49.00
			G. W. Grant, Wapping.	48.00
			Carter & Strong, Manchester.	50.00
3550	Complete Potato Manure.	H. J. Baker & Bro., 215 Pearl St., New York.	S. J. Hall, Meriden.	42.00
			C. O. Jelliff & Co., Southport.	38.00
			W. F. Andross, East Hartford.	40.00
			E. W. Hawley, Newtown.	42.50

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SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station. No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3512	Potato and Tobacco Fertilizer.	Clark' Cove Fertilizer Co., Boston, Mass.	W. H. Anderson, Putnam.	$32.00
3533	Potato Manure.	Mapes' Formula & Peruvian Guano Co., 143 Liberty St., New York.	J. P. Barstow & Co., Norwich.	41.00
			Mapes Branch, Hartford.	41.00
			Wilson & Burr, Middletown.	42.00
			G. K. Nason, Willimantic.	42.50
			C. W. Beardsley, Milford.	42.00
			Wheeler & Howe, Bridgeport.	45.00
3541	High Grade Special Fertilizer.	Williams & Clark's Fertilizer Co., 83 Fulton St., New York.	H. L. Vibberts, Manchester.	40.00
			John Bransfield, Portland.	40.00
			S. D. Woodruff & Sons, Orange.	37.00
3549	Great Eastern Vegetable and Tobacco Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vermont.	S. D. Woodruff & Sons, Orange.	33.00
			F. E. Mirritt, Noank.	31.00
			J. E. Comstock, New London.	32.00
			W. Burr & Son, Fairfield.	34.00
			S C. Lewis, Stratford.	33.00
3535	Stockbridge Manure for Potatoes and Vegetables.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	L. Browning, New London.	42.00
			C. W. Michael & Co., Yalesville.	42.00
			C. H. Bell, Portland.	42 00
			J. E. Leonard, Jewett City.	40.00
			E. M. Brewster, Norwich.	42.00
			W. H. Anderson, Putnam.	40.00
3538	Tobacco Grower.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	H. K. Brainard, Thompsonville.	45.00
			M. McNamara, New Milford.	40.00
			G. W. Mitchell, South Britain.	38.00
3532	Special Potato Manure.	Crocker Fertilizer Co., Buffalo, N. Y.	J. E. Leonard, Jewett City.	40.00
			W. H. Anderson, Putnam.	36.00
			W. L. L. Spencer, Lebanon.	40.00

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SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3604	Completo Manure for Corn and Grain.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	M. G. Beach & Son, New Milford.	$41.00
			Strong & Tanner, Winsted	38.00
3548	Great Eastern Grass and Grain Fertilizer.	Great Eastern Fertilizer Co, Rutland, Vt.	J. E. Comstock, New London.	32.00
			W. Burr & Son, Fairfield.	34.00
			S. C. Lewis, Stratford.	33.00
			F. E. Mirritt, Noank.	
3581	Stockbridge Manure for Corn and Grain.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Southington Lumber & Feed Co., Southington.	41.50
			G. H. Larned, Pomfret.	40.00
			G. W. Mitchell, South Britain.	38.00
			J. A. Lewis, Willimantic.	40.00
			Waldo Tillinghast.	40.00
			W. B. Martin, Rockville.	41.00
			J. A. Weed, New Canaan.	42 00
3614	Potato Manure.	Lister's Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	40.00
3546	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	G. W. Clark, Milford.	
			W. L. L. Spencer, Lebanon.	32.00
			J. E. Leonard, Jewett City.	31.00
			W. H. Anderson, Putnam.	33.00
			W. Tillinghast, Plainfield.	35.00
			C. A. Young, Danielsonville.	33.00
3618	Potato Fertilizer.	E. Frank Coe, 16 Burling Slip, New York.	J. O. Fox & Co., Putnam	34.00
			City Coal & Wood Co., New Britain.	36.00
			Arnold Rudd, New London.	38.00

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SPECIAL MANURES SAMPLED BY THE STATION.— *Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3684	Potato Manure.	Quinnipiac Co., 7 Exchange Place, Boston, Mass.	D. C. Wood, Stratford.	$38.00
			Olds & Whipple, Hartford.	40.00
			W. L. L. Spencer, Lebanon.	35.00
			C. A. Young, Danielsonville.	36.00
			G. M. Williams, New London.	33.00
3606	Potato Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	B. Curtiss & Son, Stepney.	35.00
			G. H Larned, Pomfret.	
			T. E. Greene, Torrington.	38.00
3531	Potato, Tobacco and Hop Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	F. C. Sturtevant. Hartford.	38.00
			John Bransfield, Portland.	36.00
			J. E. Leonard, Jewett City.	35.00
			W. H. Anderson, Putnam.	32.00
			C. A. Young, Danielsonville.	35.00
			Waldo Tillinghast, Plainfield.	36.00
3528	Potato Manure.	Bradley Fertilizer Co., 27 Kilby St., Boston, Mass.	S. A. Billings, Meriden.	38.00
			Wilson & Burr, Middletown.	35.00
			J. M. Young, Norwich.	35.00
			J. E. Holmes, Stratford.	37.00
			T. F. Powers, Waterford.	35.00
			A. C. Sternberg, Hartford.	37.00
			J. A. Lewis, Willimantic.	36.00
			J. E. Comstock, New London.	36.00
3542	Potato Phosphate.	Williams & Clark Fertilizer Co., 83 Fulton St., New York.	H. K. Brainard, Thompsonville.	36.00
			J. P. Kingsley's Sons, Plainfield.	32.00
			W. H. Anderson, Putnam.	36.00
			D. B. Wilson, Waterbury.	36.00
			C. E. Stagg, Stratford.	36.00
			Daniel Morgan, Poquonock Bridge.	34.00
3615	General Fertilizer for Oats, Buckwheat and Seeding Down.	Great Eastern Fertilizer Co., Rutland, Vermont.	J. E. Comstock, New London.	31.00
			E. B. Calkin, Lyme.	
3645	Special Potato Fertilizer.	Pacific Guano Co., Box 1368, Boston, Mass.		32.00
			P. J. Bolan, Waterbury.	35.00

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Analyses of Special Manures Sampled by the Station.

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3507	Fairchild's Formula for Corn and General Crops	3.61	....	2.13	5.74	*5.0*				13.05	*12.0*	....	....	13.66	*12.0*	11.07	$46.00	$45.11	1.9
3671	Danbury Fertilizer Co's Tobacco Fertilizer	1.78	....	2.89	4.67	*3.3*	3.04	6.43	1.60	11.07	*6.0*	9.47	....	4.16	*4.5*	.64	35.00	33.20	5.4
3673	Danbury Fertilizer Co's Potato Manure	....	....	2.84	2.84	*2.9*	4.34	6.97	1.10	12.41	*8.0*	11.31	....	6.71	*7.0*	3.63	35.00	32.22	8.6
3629	Mapes' Manure for Seeding Down	.58	....	2.58	3.16	*2.5*	....	7.98	8.11	16.09	....	7.98	*7.0*	11.03	*10.0*	9.69	37.50	34.35	9.1
3625	Mapes' Manure for Fruit and Vines	.32	.59	1.68	2.59	*1.7*	6.32	2.74	.80	9.86	....	9.06	*7.0*	10.75	*11.0*	.76	38.00	33.67	12.8
3626	Mapes' Tobacco Starter	.38	.61	1.98	2.97	*2.5*	7.73	4.35	1.06	13.14	*12.0*	12.08	*8.0*	3.07	*2.5*	.37	35.00	31.00	12.9
3576	Baker's Corn Manure	....	3.78	.95	4.73	*4.9*	6.24	.75	.25	7.24	....	6.99	*6.2*	7.40	*7.0*	5.07	38.00	33.56	13.2
3545	Mapes' Manure for Light Soils	1.03	1.68	2.39	5.10	*4.9*	6.56	2.45	.78	9.79	*8.0*	9.01	*6.0*	7.07	*6.0*	6.87	42.00	36.56	14.8
3508	The Rogers & Hubbard Co's Soluble Potato Manure	.69	.23	3.97	4.89	*5.0*	1.82	5.59	2.90	10.31	*10.0*	7.41	....	5.28	*5.0*	.54	38.00	32.97	15.2
3585	Bradley's Complete Manure for Potatoes & Vegetables	.38	1.13	2.12	3.63	*3.7*	6.86	2.84	1.24	10.94	*9.0*	9.70	*8.0*	6.45	*6.0*	3.11	38.00	32.92	15.4
3526	Mapes' Grass and Grain Spring Top Dressing	.95	1.05	2.95	4.95	*4.2*	5.66	2.78	.75	9.19	*7.0*	8.44	*5.0*	5.54	*5.0*	5.32	39.00	33.64	15.9
3575	Baker's Complete Tobacco Manure	....	3.36	1.15	4.51	*4.2*	4.42	.94	.08	5.44	....	5.36	*4.0*	10.55	*10.0*	.60	41.00	34.87	17.5
3640	L. Wilcox's Potato, Onion and Tobacco Fertilizer	.67	.59	2.54	3.80	*3.2*	3.39	3.92	.46	7.77	*8.0*	7.31	*7.0*	6.24	*6.0*	2.26	34.00	28.79	18.1

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Analyses of Special Manures Sampled by the Station.

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3546	Quinnipiac Havana and Seed Leaf Tobacco Fertilizer	....	2.17	3.34	5.51	*5.7*	.32	5.54	4.90	10.76	*6.0*	5.86	*5.0*	12.28	*10.0*	1.05	50.00	41.72	19.8
3544	Mapes' Manure for Corn	.88	.78	2.12	3.78	*3.7*	6.56	3.34	1.78	11.68	*10.0*	9.90	*8.0*	6.37	*6.0*	5.55	40.00	33.11	20.8
3584	Stockbridge Top Dressing	2.91	....	2.13	5.04	*5.0*	1.76	5.66	4.91	12.33	*6.0*	7.42	*3.0*	5.52	*5.0*	6.08	40.00	33.04	21.0
3628	Mapes' Tobacco Manure, Wrapper Brand	1.16	3.16	1.89	6.21	*6.7*	.61	3.49	1.85	5.95	*4.5*	4.10	....	11.49	*10.5*	.86	48.00	39.54	21.3
3603	Bradley's High Grade Tobacco Manure	....	3.03	2.73	5.76	*5.7*	1.68	2.57	1.25	5.50	*4.0*	4.25	....	10.70	*10.8*	.80	46.00	37.52	22.6
3550	Baker's Complete Potato Manure	.18	2.62	.93	3.73	*3.3*	5.01	1.18	.65	6.84	....	6.19	*5.0*	10.66	*10.0*	3.54	40.50	32.90	23.1
3612	Clark's Cove Fertilizer Co's Potato and Tobacco Fert.	....	....	2.38	2.38	*2.5*	7.52	2.61	1.47	11.60	*9.0*	10.13	*8.0*	3.05	*3.0*	3.12	32.00	25 89	23.6
3533	Mapes' Potato Manure	.83	.78	2.15	3.76	*3.7*	6.90	2.21	.55	9.66	*8.0*	9.11	*8.0*	7.45	*6.0*	.44	42.00	33.84	24.1
3641	Williams & Clark's High Grade Special for Potatoes, Tobacco, etc.	.24	1.19	2.22	3.65	*3.7*	6.00	2.74	.93	9.67	*8.0*	8.74	*7.0*	7.13	*7.0*	5.35	40.00	31.63	26.4
3549	Great Eastern Vegetable and Tobacco Fertilizer	.05	....	2.20	2.25	*2.1*	7.57	.95	.84	9.36	*9.0*	8.52	*8.0*	6.28	*6.0*	5.83	33.00	25.87	27.5
3535	Stockbridge Manure for Potatoes and Vegetables	1.54	....	2.11	3.65	*3.2*	5.66	2.95	2.14	10.75	*8.0*	8.61	*7.0*	6.66	*5.0*	7.21	40.00	30.83	29.7
3583	Bowker's Tobacco Grower	.91	....	1.67	2.58	*2.5*	6.99	2.77	1.18	10.94	*12.0*	9.76	*8.0*	6.45	*7.0*	2.47	39.00	29.35	32.8
3532	Crocker's Special Potato Manure	....	.20	3.47	3.67	*3.7*	6.16	1.20	2.27	9.63	*9.0*	7.36	*8.0*	6.09	*5.4*	6.15	39.00	29.11	33.9

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Analyses of Special Manures Sampled by the Station.

Station No.	Name or Brand.	Nitrogen					Phosphoric Acid.							Potash.		Chlorine.	Cost per Ton.	Valuation per Ton.	Percentage difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen Found.	Nitrogen Guaranteed.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
3604	Bradley's Complete Manure for Corn and Grain	.29	.60	2.29	3.18	*2.9*	7.60	2.90	.76	11.26	*9.0*	10.50	*8.0*	4.19	*3.0*	4.29	40.00	29.83	34.0
3548	Great Eastern Grass and Grain Fertilizer	trace	....	2.95	2.95	*2.9*	7.42	1.27	.76	9.45	*9.0*	8.69	*8.0*	2.11	*2.0*	4.10	33.00	24.55	34.4
3581	Stockbridge Manure for Corn and Grain	1.15	....	2.01	3.16	*3.2*	7.12	3.14	1.51	11.77	*9.0*	10.26	*8.0*	4.46	*7.0*	4.11	40.00	29.57	35.2
3614	Lister's Potato Manure	....	1 56	2.23	3.79	*3.7*	5.92	1.11	.74	7.77	*7.0*	7.03	....	6.51	*7.0*	5.93	40.00	29.18	37.1
3546	Crocker's Ammoniated Wheat & Corn Phosphate	....	....	2.25	2.25	*2.0*	6.91	2.77	2.63	12.31	*10.0*	9.68	*9.0*	1.61	*1.6*	2.00	33.00	23.95	37.8
3618	E. F. Coe's Potato Fertilizer	....	.70	1.63	2.33	*2.0*	6.05	2.39	1.67	10.11	....	8.45	*8.0*	4.96	*5.8*	.71	36.00	26.04	38.2
3684	Quinnipiac Potato Manure	....	....	2.78	2.78	*2.5*	4.64	2.83	1.30	8.77	*7.0*	6.47	*6.0*	5.29	*5.0*	3.83	36 00	25.14	43.1
3606	Bowker's Potato Phosphate	.70	....	1.78	2.48	*2.5*	6.85	1.80	3.43	12.08	*11.0*	8.65	*7.0*	2.43	*3.0*	3.51	35.00	24.15	44.9
3531	Crocker's Potato, Tobacco and Hop Phosphate	....	....	2.15	2.15	*2.0*	6.26	2.81	2.35	11.42	*11.0*	9.07	*10.0*	3.21	*3.5*	3.63	35.00	24.03	45.6
3528	Bradley's Potato Manure	.21	....	2.63	2.84	*2.5*	4.67	2.30	1.50	8.47	*8.0*	6.97	*6.0*	5.26	*5.0*	6.59	36.00	24.61	46.2
3542	Williams & Clark's Potato Phosphate	....	....	2.56	2.56	*2.5*	5.17	2.11	.78	8.06	*7.0*	7.28	*6 0*	5.64	*5.0*	3.09	36.00	24.59	46.4
3615	Great Eastern Fertilizer for Oats, Buckwheat and Seeding Down	trace	....	1.41	1.41	*0.8*	7.20	1.10	.90	9.20	*9.0*	8.30	*8.0*	4.59	*4.0*	5.95	32.00	21.34	49.9
3645	Pacific Guano Co's Special Potato Fertilizer	....	.31	2.56	2.87	*3.0*	3.25	2.74	1.71	7.70	*7.0*	5.99	*5.0*	4.92	*5.0*	5.74	35.00	23.11	51.4

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Home Mixed Fertilizers.

Following are the formulas, analyses and valuations of all the Home mixtures which have been received at this Station for analysis during the past season.

The prices quoted except in the case of **3443** are *regular market retail rates*, at which the goods can be bought without discounts. In most cases special and much lower prices were paid partly on account of large orders and cash payments.

The mechanical condition of most of these mixtures was excellent, being as fine and as dry as average factory-mixed goods.

The average cost of the raw material used in the mixtures, excluding 3443 was $33.25 at regular market rates, disregarding discounts, which most of the purchasers received. If we add to this $1.50 for freight and $2.00 per ton for mixing, an allowance which is very ample, the total average cost will be $36.75 per ton. The average valuation is $33.16 per ton, and the percentage difference between cost and valuation $10.8.

The percentage differences between cost and valuation in case of the factory-mixed superphosphates and special manures this year is more than twice as large, indicating that there was in these cases great economy in home-mixing.

3443. Made by S. E. Curtiss, Stratford.

Formula.

2530	pounds	Muriate of Potash.
800	"	Nitrate of Soda.
6400	"	Dissolved Bone.
1400	"	Dissolved Bone Black.
4500	"	Tankage.
15630	"	

Costing $176.00 or $22.52 per ton.

3476. For General Use, made by J. Norris Barnes, Yalesville.

300	pounds	Nitrate of Soda.
1000	"	Pulverized Bone and Meat.
4000	"	Blood, Bone and Meat.
1200	"	Raw Bone.
800	"	Dissolved Bone Black.
1125	"	Muriate of Potash.
800	"	Double Sulphate Potash and Magnesia.
9225	"	

Costing $35.27 per ton delivered at Yalesville at regular rates.

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3486. For General Use, made by N. D. Platt, Milford.

2000	pounds	Tankage.
2000	"	Dissolved Bone Black.
500	"	Ground Bone.
500	"	Sulphate of Ammonia.
500	"	Muriate of Potash.
500	"	Double Sulphate of Potash.
	"	
6000	"	

Costing, at regular rates, $35.00 per ton in Milford.

3487. For General Use, made by R. M. Treat, Woodmont.

450	pounds	Tankage.
170	"	Sulphate of Ammonia.
1000	"	Dissolved Bone Black.
280	"	Muriate of Potash.
100	"	Bone Black.
	"	
2000	"	

Costing, at regular rates, $34.67 per ton.

3488. Made by G. F. Platt, Milford.

800	pounds	Blood, Bone and Meat.
400	"	Ground Bone.
550	"	Dissolved Bone Black.
50	"	Sulphate of Ammonia.
100	"	Nitrate of Soda.
50	"	Sulphate of Potash.
50	"	Muriate of Potash.
	"	
2000	"	

Costing, at retail rates $34.51 per ton.

3489. For general use. Made by W. L. and S. T. Merwin, Milford.

170	pounds	Muriate of Potash.
950	"	Dissolved Bone Black.
580	"	Tankage.
175	"	Sulphate of Ammonia.
125	"	Ground Bone.
2,000	"	Costing, at regular rates, $34.60 per ton.

3503. For general use. Made by N. E. Smith & Son, Woodmont.

475	pounds	Tankage.
145	"	Sulphate of Ammonia.
1,000	"	Dissolved Bone Black.
280	"	Muriate of Potash.
100	"	Bone Black.
2,000	"	Costing, at regular rates, $34.09 per ton.

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3504. For Potatoes. Made by T. J. Stroud, Shaker Station.

500	pounds	Castor Pomace.
600	"	Tankage.
300	"	High grade Sulphate of Potash.
100	"	Nitrate of Soda.
400	"	Dissolved Bone Black.
100	"	Plaster.
2,100	"	Costing about $30.25 per ton.

3505. For Oats. Made by T. J. Stroud, Shaker Station.

700	pounds	Castor Pomace.
800	"	Tankage.
200	"	Muriate of Potash.
300	"	Nitrate of Soda.
100	"	Plaster.
2,100	"	Costing about $30.60 per ton.

3517. Made by E. Kingsbury, Coventry.

1,000	pounds	Tankage.
400	"	Muriate of Potash.
400	"	Dissolved Bone Black.
300	"	Nitrate of Soda.
2,100	"	Costing $36.00 in Coventry, allowing $1.00 for mixing.

3519. For Corn. Made by G. F. Platt, Milford.

200	pounds	Nitrate of Soda.
300	"	Ground Bone.
800	"	Dissolved Bone Black.
600	"	Blood, Bone and Meat.
100	"	Muriate of Potash.
2,000	"	Cost at regular rates, $32.82 per ton in Milford.

3520. For Potatoes. Made by Dennis Fenn, Milford.

12	bushels	Unleached Ashes.
200	pounds	Dissolved Bone Black.
400	"	Blood, Bone and Meat.
100	"	Nitrate of Soda.

3539. Made by S. O. Parker, Somerville.

662	pounds	Tankage.
662	"	Dissolved Bone Black.
534	"	Double Sulphate of Potash and Magnesia.
142	"	Sulphate of Ammonia.
2,000	"	Costing unmixed, $34.00 per ton.

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3540. For Corn. Made by Dennis Fenn, Milford.

700	pounds	Blood, Bone and Meat.
500	"	Dissolved Bone Black.
500	"	Bone.
200	"	Nitrate of Soda.
180	"	Muriate of Potash.
2,000	"	Costing, at regular rates, $36.83.

3574. For Oats and Seeding Down. Made by Stephen Hoyt's Sons, New Canaan.

1,000	pounds	Bone Dust.
600	"	Double Sulphate of Potash and Magnesia.
200	"	Muriate of Potash.
200	"	Nitrate of Soda.
2,000	"	Costing $36.25 per ton at regular rates.

3586. For Corn. Made by T. J. Stroud, Shaker Station.

800	pounds	Castor Pomace.
900	"	Tankage.
200	"	Muriate of Potash.
100	"	Nitrate of Soda.
100	"	Plaster.
2,100	"	Costing about $31.00 per ton at regular rates.

3601. Special for Corn. Made by Dennis Fenn, Milford.

25	bushels	Hen Manure.
400	pounds	Land Plaster.
200	"	Dissolved Bone Black.
100	"	Muriate of Potash.

3607. For Corn. Made by N. E. Smith & Son.

600	pounds	Blood, Bone and Meat.
300	"	Ground Bone.
800	"	Dissolved Bone Black.
200	"	Nitrate of Soda.
100	"	Muriate of Potash.
2,000	"	Costing, at regular rates, $32.82 per ton.

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HOME MIXED FERTILIZERS.—ANALYSES AND VALUATIONS.

Station No.	Name.	Nitrogen.					Phosphoric Acid.					Potash.		Chlorine.	Valuation, Per Ton.	Cost of Raw Materials per ton, delivered.
		As Nitrates.	As Ammonia.	Organic.	Total Found.	Total Calculated.	Soluble.	Reverted.	Insoluble.	Total Found.	Total Calculated.	Found.	Calculated.			
3443	S. E. Curtiss, Home Mixture	.72	.....	1.53	2.25	.....	7.06	1.90	1.27	10.23	.....	7.62	*8.2*	.....	$27.68	*$22.52
3476	J. N. Barnes, Mixture for Gen'l Use	.43	.....	3.67	4.10	*4.5*	1.58	4.79	3.74	10.11	*11.5*	11.09	*8.4*	5.75	34.27	35.27
3486	N. D Platt, Mixture for Gen'l Use,	.....	1.77	2.07	3.84	*3.7*	6.34	3.59	3.03	12.96	*14.5*	6 03	*6.2*	4.06	34.12	35.00
3487	R. M. Treat, Mixture for Gen'l Use,	.....	1.76	1.24	3.00	*3.1*	8.99	1.80	2.51	13.30	*14.2*	7.61	*6.8*	7.32	33.98	34.67
3488	G. F. Platt, Mixture for Potatoes,	.63	.58	2.94	4.15	*4.4*	5.14	5.02	5.47	15.63	*15.7*	1.82	*1.9*	1.24	31.94	34.51
3489	W. L. & S. T. Merwin, Mixture for General Use,	.....	1.46	1.99	3.45	*3.9*	9.46	2.91	1.74	14.11	*12.6*	4.54	*4.3*	4.86	34.53	34.60
3503	N. E. Smith & Son, Mixture for Gen'l Use	.....	2.10	1.37	3.47	*3.2*	9.63	1.95	1.66	13.27	*12.1*	6.94	*6.8*	5.01	35.87	34.09
3504	T. J. Stroud, Mixture for Potatoes,	.56	.....	3.30	3.86	.....	4 37	.76	.18	5.31	.....	7.25	.....	.41	27.80	30.25
3505	T. J. Stroud, Mixture for Oats,	2.39	.....	4.60	6.99	*6.8*	.90	1.00	.06	1.96	*1.8*	4.68	*5.1*	3 97	28.87	30.60
3517	E. Kingsbury, Home Mixture,	2.23	.....	2.31	4.54	*5.0*	2.76	3.03	1.18	6.97	*8.7*	10 12	*9.5*	.....	32.04	36.00
3519	G. F. Platt, Mixture for Corn,	1.46	.....	2.39	3.85	*4.1*	7.50	4.59	2.78	14.87	*13.5*	2.50	*2.5*	.....	33.08	32.82
3520	Dennis Fenn, Mixture for Potatoes,	1.63	.....	2.22	3.85	.....	1.43	1.85	5.57	8.85	.....	2.39	.....	trace.	21.59	.....
3539	S. O. Parker, Home Mixture,	.....	1.37	2.39	3.76	*3.9*	4 48	2.39	1.42	8.29	*6.1*	7.22	*6.9*	.72	38.60	34.00
3540	Dennis Fenn, Mixture for Corn,	1.26	.....	2.72	3.98	*4 6*	4.35	5.91	4.21	14.47	*13.5*	4.07	*4 3*	.....	32.62	36.83
3574	Stephen Hoyt's Sons, Mixture for Oats and Seeding Down,	2.79	.....	2.42	5.21	*3.2*	.....	.....	.....	9.98	*9.3*	9.80	*12.8*	2.25	39.17	36.25
3586	T. J. Stroud, Mixture for Corn,	.92	.....	3.34	4.26	*5 9*	3.68	.86	trace.	4.54	*1.4*	6.50	*5.2*	5.73	26.02	31.00
3601	Dennis Fenn, Mixture for Corn (Special),	.....	.....	1.05	1.05	.....	1.09	2.04	.....	3.13	.....	4.18	.....	.....	11.62	.....
3607	N. E. Smith & Son, Mixture for Corn,	1.52	.....	2.14	3.66	*4.1*	7.36	5.02	.92	13.30	*13.6*	5.05	*2.5*	4.32	34.40	32.82

* Not at regular market rates.

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Miscellaneous Fertilizers and Manures.

Cotton-Hull Ashes.

The analyses of 25 samples of this material are tabulated on page 107.

Samples **3473** and **3636** represent damaged or refuse stock, sold as such by Messrs. Soper & Co., on the basis of the Station's analysis, and at a very low price.

Excluding these two analyses, the actual potash in Cotton-Hull ashes has cost as high as 11.4 cents per pound, as low as 3.2 cents per pound, and on the average 5.3 cents.

The per cent. of potash has ranged from 31.3 to 11.3, and the average has been 24.1 per cent.

Unleached Ashes.

From various Dealers.

3497. From W. E. Fyfe & Co., Clinton, Mass. Sampled by Station agent from stock of A. C. Sternberg, Hartford.

3715. From James Hartness Soap Co., Detroit, Mich. Sampled by J. N. Barnes from stock bought by him.

3522. From Forest City Hardwood Ash Co. Sampled by E. C. Warner, Fair Haven, from stock purchased by him.

3705. From Forest City Hardwood Ash Co. Sampled and sent by H. G. Swift, West Hartford.

Sold by Chas. Allison & Co., New York City.

3417. Sampled by L. S. Ellsworth, Simsbury.

3428. Sampled by W. H. Whitehead, Simsbury.

3445. Sampled by Jay Barnard, Simsbury.

3692. Sampled by C. S. Gillette, Cheshire.

Sold by F. R. Lalor, Dunnville, Ontario, Canada.

3416. Sampled by Station agent.

3437, 3538. Two samples from the same pile, drawn by T. J. Stroud, Shaker Station.

3439 and **3440.** Sampled by C. F. Smith, Orange.

3693. Sampled by Station agent from goods purchased by E. J. Peck, Stratford.

3695. Sampled by Julius Moss, West Cheshire.

3696. Sampled by C. C. Hart, Southington.

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Analyses of Cotton Hull Ashes.

Station No.	Dealer or Purchaser.	Sampled by	Soluble Phosphoric Acid.	"Reverted" Phosphoric Acid.	Insoluble Phosphoric Acid.	Potash Soluble in Water.	Cost per ton.	Valuation per ton.	Potash, costs per pound in cents.
3460	H. K. Brainard, Thompsonville	R. L. Clapp, Thompsonville	2.08	7.64	1.03	28.26	$36.00	$49.00	3.2
3423	T. Soule & Co., New Milford	E. A. Wildman, New Milford	2.96	6.69	1.63	31.34	35.00	49.93	3.3
3463	H. K. Brainard, Thompsonville	James Wood, West Suffield	1.84	7.63	1.46	26.14	33.00	42.78	3.6
3444	H. K. Brainard, Thompsonville	G. F. Chapin, Thompsonville	2.34	6.15	2.72	28.96	36.00	45.07	3.9
3424	T. Soule & Co., New Milford	E. A. Wildman, New Milford	2.24	6.23	1.38	27.53	35.00	42.91	4.1
3453	Olds & Whipple, Hartford	H. S. Frye, Poquonock	2.64	7.06	2.75	29.42	40.00	47.30	4.3
3475	I. L. Spencer, Suffield	C. W. Austin, Suffield	1.47	6.27	2.17	27.00	35.00	41.56	4.3
3472	Olds & Whipple, Hartford	Eugene Brown, Poquonock	2.40	7.10	1.89	25.88	37.00	42.77	4.4
3446	Olds & Whipple, Hartford	E. J. Wells, East Windsor Hill	2.37	7.37	2.82	28.46	40.00	46.31	4.4
3434	W. J. Barber, Canton	W. J. Barber, Canton	1.17	7.46	2.03	28.37	40.00	44.23	4.7
3435	W. J. Barber, Canton	W. J. Barber, Canton	1.28	6.01	2.94	24.18	35.00	38.11	4.8
3468	Olds & Whipple, Hartford	Eugene Brown, Poquonock	1.04	8.82	2.55	25.82	40.00	43.33	4.8
3414	Olds & Whipple, Hartford	Olds & Whipple, Hartford	.59	7.77	1.53	22.07	35.00	36.67	5.1
3425	I. L. Spencer, Suffield	L. F. Woodworth, Thompsonville	1.04	7.51	2.94	20.44	35.00	35.73	5.3
3573	F. W. Rising, West Suffield	F. C. Root, Suffield	1.22	7.61	3.09	24.62	42.00	40.81	5.7
3704	Eugene Brown, Poquonock	Eugene Brown, Poquonock	.60	6.71	.77	25.83	40.00	39.01	5.7
3465	D. L. Brockett, Suffield	D. L. Brockett, Suffield	.50	6.85	1.41	21.54	36.00	34.59	5.8
3433	Chas. L. Austin, Suffield	F. C. Root, Suffield	1.02	6.08	2.17	21.40	37.00	34.45	6.1
3452	G. H. & J. H. Hale, Glastonbury	S. O. Griswold, Poquonock	1.34	5.67	2.67	20.90	37.00	34.01	6.2
3436	E. S. Clark, Hartford	E. S. Clark, Hartford	------	4.23	1.81	21.00	33.00	29.74	6.3
3422	A. D. Bridge	W. P. Henry, Scitico	.64	8.22	2.05	17.22	35.00	32.23	6.3
3623	Seth Viets, West Suffield	F. C. Root, Suffield	.74	6.75	2.07	16.02	42.00	29.01	9.5
3622	Seth Viets, West Suffield	F. C. Root, Suffield	.80	5.60	3.00	11.27	36.00	22.63	11.4
3473	J. E. Soper & Co., Boston, Mass.*	Arthur Sikes, Suffield	.24	3.40	1.30	7.02	------	13.36	-----
3636	J. E. Soper & Co., Boston, Mass.*	Arthur Sikes, Suffield	.93	3.17	1.57	8.67	------	16.01	-----

* See note on page 106.

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Analyses of Unleached Canada Ashes.

	3497	3715	3522	3705	3417	3428	3445	3692	3416	3427	3538	3439	3440	3693	3695	3696
Potash, soluble in water	3.34	4.68	3.59	2.66	4.36	4.36	5.40	5.39	4.92	4.21	4.17	4.30	4.76	4.70	3.14	6.34
Potash, total	---	---	---	4.71	---	---	---	7.46	---	---	5.02	---	---	6.09	3.75	8.15
Phosphoric acid	1.15	1.44	1.05	1.38	1.47	1.03	1.41	.90	1.73	1.00	1.16	---	---	1.41	.83	1.47
Cost per ton	$12.00	10.00*	11.50	11.00*	12.00	12.00	12.00	---	12.00	11.00	11.00	12.00	12.00	12.00	---	11.00

* In car lots.

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Notes of Certain Samples.

3705 was bought on agreement that the ashes were to be dry, weighing 40 to 50 pounds per bushel. The actual weight proved to be 85 pounds per bushel.

The full analysis was as follows:

Water	42.29
Sand and silica	2.61
Charcoal	.75
Potash, soluble in water, (mostly carbonate)	1.54
Potash, only soluble in acids, (as silicates)	2.73
Phosphoric acid	.80
Lime, magnesia, oxide of iron, alumina, soda, sulphuric acid, and carbonic acid, not separately determined,	49.28
	100.00

3437 and **3538** were bought on a guarantee of "five per cent. potash." It is seen that while the ashes contain 5.02 per cent. of actual potash, only about 4.2 per cent. is soluble in boiling water. The rest exists in the form of silicates, quite insoluble in water and much less readily available to plants.

3439 and **3440** represent small samples drawn from two places in a car load of ashes, and there is no proof that they represent the average quality of the whole.

Attention is again called to the Station's instructions for sampling ashes. A strict adherence to them is necessary in order to secure a *fair sample*, without which a chemical analysis is worse than useless. These are as follows:

Instructions for Sampling Ashes.

In case of Fertilizers in bulk as Canada Ashes or Cotton Hull Ashes, it is needful that at least 20 or 30 small portions, cupfuls,* be taken from as many different parts of the car load or heap—from its top, center and bottom, and from each end and side. These should be thrown into a clean box or barrel and thoroughly intermixed, *and of this mixture* 1 *quart* should be put in a sealed jar for analysis.

* A shovel may be used if the material is a moist and coherent powder, but in cases of dry and lumpy fertilizers a cup or deep scoop should be used and all heaping, which allows the lumps to roll away from the finer substance, should be avoided.

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Ashes must be sampled before exposure to rain or sun as their composition is liable to considerable alteration by such exposure.

The sample *must* be described and its correctness certified on a blank form which the Station will send as requested.

"Fossiliferous Phosphatic Marl."

"Natural Plant Food."

A sample of material, **3747**, bearing this name, was brought to this Station by Alpheus Winter, of Middletown, general agent of The Southern Phosphate Co. of Richmond, Va. The circulars accompanying the sample describe it as phosphatic marl, which is obtained from the valley of the Pamunkey River in Virginia, and is said to be used in that State as a fertilizer with wonderful results.

The Station is informed that it is being introduced here and sold in considerable quantities at $9.75 per ton.

The published analyses of different strata of the marl show from 6.4 to 14.6 per cent. of phosphoric acid and from .35 to 2.66 per cent. of potash. Evidently it is not of very uniform composition.

The sample above referred to had the following composition:

Potash	.23
Lime	8.10
Magnesia	.55
Oxide of iron and alumina	3.81
Sand and silica	68.86
Carbonic acid	5.60
Phosphoric acid	1.69
Sulphuric acid	.76
Water	8.93
Undetermined matters	1.47
	100.00

The Station is informed that this sample represents the average quality of shipments about to be made.

The analysis shows that more than eighty per cent. of the sample consists of sand, silica and moisture, matters of no value whatever in a fertilizer. The phosphoric acid is insoluble in water, and for the most part insoluble in ammonium citrate, and it is probably about as available to plants as that of the phosphatic guanos. The phosphatic and potash-yielding marls have

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been used with great success in New Jersey and Virginia for years, where they could be had at a cost of very little more than the carting, and were applied in large quantities, and it is likely that many of our soils would respond satisfactorily to heavy applications of this marl.

Whether at the price asked the marl can profitably be used by Connecticut farmers is a question to be settled by practical trials; whether the shipments can be made of uniform quality further analyses must determine.

Phosphatic Marl.

Below are given two analyses of marl; one sample **3685**, taken near the surface, the other, **3686**, six feet below the surface. These were drawn near Richmond, Va., by Capt. J. K. Bucklyn, of Mystic, Conn., and are similar in general character to the marl referred to above, but richer in phosphates.

ANALYSES.	3685.	3686.
Potash	.49	.52
Soda	.62	.65
Lime	14.39	19.09
Magnesia	.52	.36
Oxide of iron and alumina	5.17	3.61
Sand and silica	60.57	54.26
Carbonic acid	5.20	4.30
Phosphoric acid	5.93	8.99
Sulphuric acid	1.99	2.07
Water	5.12	6.15
	100.00	100.00

Oyster Shell Lime.

3415. Made by H. A. Stevens, 39 South Front street, New Haven. 600 bushels make a car load, 42–45 pounds per bushel. Cost 12 cents per bushel. The ton, of 46 bushels, costs $5.52.

ANALYSIS.	
Insoluble matters	.93
Water (free and combined)	23.17
Carbonic acid	3.85
Lime	69.55
Magnesia	.76
Oxide of iron and alumina	.58
Phosphoric acid	trace
Sulphuric acid	.72
Undetermined and loss	.44
	100.00

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This material has been quite extensively used the last year by tobacco growers and others.

A Soap Factory Refuse.

3697. Regarding this, J. M. Hubbard, of Middletown, writes: "It is produced by Allison Brothers, soap manufacturers. It consists of tankage from their works, mixed with dry ashes to facilitate handling. They make from one to two tons per week, hardly enough to pay for drying and thorough manipulation."

ANALYSIS.

Nitrogen	.84
Soluble phosphoric acid	trace
Reverted phosphoric acid	1.56
Insoluble phosphoric acid	4.12
Potash	1.23
Moisture	28.76

Calculated by the same schedule as commercial fertilizers, its valuation per ton would be $7.87, but owing to its wetness and unfavorable mechanical condition, this valuation is quite too high.

Silk Worm Waste.

3523. A sample of this material from Cheney Brothers, of South Manchester, contained 8.92 per cent. of nitrogen, .48 of phosphoric acid and .40 of potash.

Horn Waste.

3682. A sample, consisting apparently of very thin horn turnings, contained 14.43 per cent. of nitrogen and not more than traces of either potash or phosphoric acid.

Wool Waste.

3683. A sample of waste from "carbonizing" burry wool and camel's hair, from a woolen mill in Naugatuck, sent by M. S. Baldwin. The carbonizing liquor contained oil of vitriol, salt and chloride of aluminum.

The material contains neither phosphoric acid or potash, but 5.50 per cent. of nitrogen. This nitrogen is no doubt almost wholly from the wool, and is only very slowly available.

3721. "Refuse waste and dust from a shoddy mill," sent by Thomas Barrett, Scitico, contains 3.78 per cent. nitrogen.

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Tobacco Dust.

3485. Used as an insecticide and fertilizer. Made by H. F. Stoothoff, New York City. Sampled from stock of Olds & Whipple, Hartford, by Station agent.

The sample contained 1.76 per cent. of nitrogen, .52 of phosphoric acid, and 1.76 per cent. of potash.

Muck.

3702, light brown in color, **3703** dark brown, sent by Ira F. Dudley, North Guilford. **3722.** Sent by Ezekiel Reynolds, Stanwich.

ANALYSES.

	3702.		3703.		3722.	
	As received.	Water-free.	As received.	Water-free.	As received.	Water-free.
Water	71.12	---	71.90	---	72.26	---
*Vegetable matter	7.79	26.95	23.45	83.39	19.03	68.57
Oxide of iron and alumina	1.46	5.07	.98	3.47	---	---
Lime	.24	.84	.92	3.25	---	---
Magnesia	.24	.83	trace	trace	---	---
Potash	.06	.21	.03	.11	.04	.14
Soda	.03	.10	.04	.15	---	---
Sulphuric acid	.15	.52	.20	.79	---	---
Phosphoric acid	trace	trace	trace	trace	.06	.20
Sand and silica	18.91	65.48	2.48	8.84	5.62	---
	100.00	100.00	100.00	100.00		
*Containing nitrogen	.25	.86	.35	1.23	.43	1.54

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REVIEW OF THE FERTILIZER MARKET.

For the Twelve Months ending December 31, 1892.

Nitrogen.

Nitric Nitrogen.

The *wholesale* New York quotation of nitrogen in nitrate of soda, which was 13.3 cents per pound in December, 1891, opened in January, 1892 at 12.9 and fell gradually, being quoted in May at 10.5 cents. It then rose to 11.1 in July, and since then has risen steadily and rapidly, being 13.7 cents in November and December. This sharp rise is due to the scarcity of nitrate of soda in this country, owing to a limitation of the output by the Chilian manufacturers.

The average *wholesale* quotation for 1892 has been 12.1 cents per pound. The corresponding figures for 1891 and 1890 respectively, were 12.9 and 11.5 cents.

The *retail* ton price of nitrogen in nitrate of soda in this State during the last season has been from 14 to 15½ cents per pound.

Ammonic Nitrogen.

The *wholesale* price in New York of nitrogen in sulphate of ammonia has been quite uniform. The average monthly quotation was 14.7 cents from January till September. It fell to 14.0 cents in October, and has remained at that figure ever since.

The average *wholesale* quotation for the twelve months has been 14.5 cents per pound. The average for the years 1891 and 1890 has been 15.6 cents and 16 cents respectively.

The *retail* price of nitrogen in sulphate of ammonia in Connecticut has been not far from 17½ cents per pound for the whole season.

Organic Nitrogen.

The *wholesale* quotation of nitrogen in high grade Red Blood, which was 12.2 cents per pound in January, fell to 11.5 in March, and since then has risen steadily and in the last months of the year rapidly, being 13 cents in October, 14.1 cents in November, and 14.6 cents in December.

The quotations of nitrogen in black blood, are as a rule, from three-tenths to five-tenths of a cent per pound less.

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The average quotation for the whole year has been 12.4 cents per pound for nitrogen in red blood and 12.0 cents in black blood. In 1891 these average figures were 12.3 and 11.7. In 1890 they were 11.8 and 11.3 cents.

Dried blood is seldom met with in the Connecticut retail market.

Nitrogen in Azotin was quoted in January and February last at 11.5 cents *wholesale*, from then till September at 11.2, and since then has risen rapidly to 12.6 in October, 13.7 in November, and 14.8 in December. Its average quotation for the year has been 11.9 cents against 11.5 cents in 1891.

Dried Fish Scrap, which is considerably used in mixed fertilizers which was quoted in the earlier months of the year at $23.75 per ton, *wholesale*, rose in October to $24.50, in November to $24.90, and in December to $26.00. The catch of fish this year is said to have been extremely small.

Acidulated Fish Scrap has fluctuated from $12.07 to $15.00, at which latter figure it was quoted in December.

Most of the organic nitrogen sold at *retail* in this State, in unmixed goods, has been in the form of bone and tankage, or in cotton seed meal and castor pomace. As has been shown on page 66 the nitrogen of cotton seed meal has cost at *retail* in this State during the last year from 14.1 cents to 16.3 cents per pound; in castor pomace from 14.7 to 18.12 cents.

Phosphatic Materials.

Refuse Bone Black was quoted at about $18.50 per ton till September, when it began to rise, and was quoted in December at $19.50 per ton.

Rough Bone has fallen during the year from $21.50 to $19.50, and *Ground Bone* also, from $23.25 to $22.25.

Ground Charleston Rock, quoted in January and February at $9.25, has since then been quoted at $8.75.

Acid Phosphate, 14 per cent. available phosphoric acid, was quoted at 73½c. per unit till August, and since then at 66c. per unit, which is equivalent to 3.7 cents and 3.3 cents per pound for available phosphoric acid at *wholesale*.

The *retail* price in Connecticut of available phosphoric acid in dissolved bone black, as seen on page 68, has been from 5.7 cents to 8.3 cents per pound. Acid phosphate made from Charleston rock, though much cheaper, does not come into our retail market.

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POTASH.

Muriate of Potash.

The *wholesale* price of actual potash in this form has advanced during the year from 3.62 cents to 3.78 cents per pound.

It has *retailed* in Connecticut during the year for from 3.9 to 4.7 cents per pound. See page 69.

Double Sulphate of Potash and Magnesia.

The *wholesale* quotation of potash in this form has remained quite constant during the year at 4.77 cents per pound.

It has *retailed* in Connecticut at about 5.7 cents per pound. See page 68.

High Grade Sulphate of Potash.

The *wholesale* New York quotation of potash in this form has remained quite steady at 4.48 cents per pound.

The *retail* price in Connecticut has been from 5.36 to 5.7 cents per pound. See page 68.

Kainit.

The New York *wholesale* quotation has remained steady at $9.00 per ton during the whole year, at which price the actual *wholesale* cost of the potash would be about 3.7 cents per pound.

The market quotations given above are taken from the "Oil Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage and some other articles are quoted and sold by the ton. The seller usually has an analysis of his stock and purchasers often control this by an analysis at the time of purchase.

Sulphate of ammonia, nitrate of soda and muriate of potash are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

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Blood, azotin and ammonite are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the percentage of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain 8½ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.25 = \$19.13$.

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given:

Ammonia at	$3.00	per unit is	equivalent to	nitrogen at	18.2	cts. per lb.
"	2.90	"	"	"	17.6	"
"	2.80	"	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"	"	"	15.8	"
"	2.50	"	"	"	15.2	"
"	2.40	"	"	"	14.6	"
"	2.30	"	"	"	14.0	"
"	2.20	"	"	"	13.4	"
"	2.10	"	"	"	12.8	"
"	2.00	"	"	"	12.2	"
"	1.90	"	"	"	11.6	"
"	1.80	"	"	"	11.0	"

Commercial Sulphate of Ammonia contains on an average 20.5 per cent. of nitrogen, though it varies considerably in quality. With that per cent. of nitrogen (equivalent to 24.3 per cent. of ammonia),

At 4	cents	per lb.	Nitrogen costs	19.5	cents per lb.
" 3⅞	"	"	"	18.9	"
" 3¾	"	"	"	18.3	"
" 3⅝	"	"	"	17.6	"
" 3½	"	"	"	17.0	"
" 3⅜	"	"	"	16.4	"
" 3¼	"	"	"	15.8	"
" 3⅛	"	"	"	15.2	"
" 3	"	"	"	14.6	"
" 2⅞	"	"	"	14.0	"
" 2¾	"	"	"	13.4	"

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Commercial Nitrate of Soda averages 95 per cent. of pure salt or 16.0 per cent. of nitrogen.

If quoted at	3.0	cents	per pound, Nitrogen costs	18.8	cents per lb.
"	2.9	"	" "	18.2	"
"	2.8	"	" "	17.5	"
"	2.7	"	" "	16.9	"
"	2.6	"	" "	16.2	"
"	2.5	"	" "	15.6	"
"	2.4	"	" "	15.0	"
"	2.3	"	" "	14.4	"
"	2.2	"	" "	13.8	"
"	2.1	"	" "	13.2	"
"	2.0	"	" "	12.5	"
"	1.9	"	" "	11.9	"
"	1.8	"	" "	11.3	"
"	1.7	"	" "	10.6	"

Commercial Muriate of Potash and also High Grade, 98 per cent., Sulphate of Potash usually contain 50½ per cent. of actual potash.

If quoted at	2.60	cents per lb.	Actual Potash costs	5.15	cents per lb.
"	2.50	"	" "	4.95	"
"	2 40	"	" "	4.75	"
"	2.30	"	" "	4.55	"
"	2.25	"	" "	4.45	"
"	2.20	"	" "	4.35	"
"	2.15	"	" "	4.25	"
"	2.10	"	" "	4.15	"
"	2.05	"	" "	4.06	"
"	2.00	"	" "	3.96	"
"	1.95	"	" "	3.86	"
"	1.90	"	" "	3.76	"
"	1.85	"	" "	3.66	"
"	1.80	"	" "	3.56	"
"	1.75	"	" "	3.46	"
"	1.70	"	" "	3.36	"

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of actual potash.

If quoted at	1.00	cent per lb.	Actual Potash costs	3.77	cents per lb.
"	1.05	"	" "	3.96	"
"	1.10	"	" "	4.15	"
"	1.15	"	" "	4.34	"
"	1.20	"	" "	4.53	"

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The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since January, 1890. The price given for each month is the average of the four weekly quotations of that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 16.0 per cent. nitrogen, and muriate of potash 50½ per cent. of actual potash or 80 per cent. of the pure salt.

WHOLESALE PRICES OF FERTILIZING MATERIALS.

		Dried Blood.	Cost of Nitrogen at wholesale in				Cost of Potash at wholesale in			
		Red. Cents per pound.	Black or low grade. Cents per pound.	Azotin or Ammonite. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash. Cents per pound.	Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
1890.	January	12.4	11.9	12.7	12.1	15.4	3.64	4.44	4.97	4.06
	February	12.4	11.8	12.5	12.0	15.4	3.64	4.44	4.97	4.06
	March	12.1	11.8	12.2	11.9	15.4	3.64	4.44	4.89	4.06
	April	12.0	11.7	12.2	11.2	15.4	3.64	4.42	4.77	4.06
	May	11.9	11.3	12.2	11.2	15.3	3.62	4.42	4.77	4.05
	June	11.9	11.4	12.1	11.2	15.8	3.62	4.42	4.77	4.00
	July	11.9	11.4	12.0	11.2	16.6	3.62	4.42	4.77	3.69
	August	11.6	11.0	11.5	11.0	16.6	3.62	4.42	4.77	3.69
	September	11.3	10.7	11.3	11.1	16.6	3.62	4.42	4.77	3.69
	October	11.4	10.8	11.7	11.6	16.5	3.62	4.42	4.17	3.69
	November	11.5	10.9	11.4	11.6	16.5	3.55	4.27	4.06	3.69
	December	11.5	10.9	11.4	11.6	16.5	3.62	4.53	4.31	3.69
1891.	January	11.0	10.5	11.5	10.9	16.5	3.58	4.53	4.33	3.69
	February	12.0	11.0	11.5	12.5	16.5	3.58	4.53	4.33	3.69
	March	12.5	11.9	11.5	14.3	16.5	3.68	4.53	4.33	3.69
	April	12.4	12.0	11.5	14.4	16.5	3.68	4.53	4.33	3.69
	May	12.3	11.7	11.5	13.6	16.0	3.68	4.53	4.33	3.69
	June	12.3	11.7	11.5	13.2	15.5	3.68	4.53	4.33	3.69
	July	12.2	11.6	11.5	12.2	15.4	3.68	4.53	4.33	3.69
	August	12.3	11.8	11.5	11.3	15.4	3.68	4.53	4.33	3.69
	September	12.3	12.0	11.5	12.2	14.8	3.68	4.53	4.33	3.69
	October	12.3	12.0	11.5	13.6	14.7	3.68	4.53	4.33	3.69
	November	12.6	12.3	11.5	13.5	14.7	3.68	4.53	4.23	3.69
	December	12.4	12.1	11.5	13.3	14.7	3.63	4.63	4.41	3.69
1892.	January	12.2	11.5	11.5	12.9	14.7	3.62	4.79	4.45	3.69
	February	11.6	11.3	11.5	12.0	14.7	3.64	4.77	4.48	3.69
	March	11.5	11.0	11.2	12.1	14.7	3.71	4.77	4.48	3.69
	April	11.8	11.3	11.2	11.0	14.7	3.78	4.77	4.48	3.69
	May	12.0	11.5	11.2	10.5	14.7	3.78	4.77	4.48	3.69
	June	11.7	11.2	11.2	10.6	14.7	3.78	4.77	4.48	3.69
	July	12.1	11.7	11.2	11.1	14.7	3.78	4.77	4.48	3.69
	August	12.3	12.1	11.2	11.7	14.7	3.78	4.77	4.48	3.60
	September	12.4	12.0	12.0	12.4	14.2	3.78	4.77	4.48	3.30
	October	13.0	12.6	12.6	12.9	14.0	3.78	4.77	4.48	3.30
	November	14.1	13.8	13.7	13.7	14.0	3.78	4.77	4.48	3.30
	December	14.6	14.2	14.8	13.7	14.0	3.78	4.77	4.48	3.30

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THE BEHAVIOR OF NITROGEN IN THE SOIL.

The following correspondence answers questions which are frequently addressed to the Station, and is therefore of general interest.

A Connecticut farmer writes:—

"I would like you to tell me about how much of the nitrogen a crop of potatoes would get from a fertilizer that contained four per cent., and what would become of what the crop did not use. I would like to ask the same about nitrate of soda, sulphate of ammonia, dried blood and tankage, it being understood that these articles were sown in the drill at the planting time.

In the second place, if ground plaster is mixed with these goods, would the potatoes get any more of the nitrogen than without?

How long after nitrogen in the above forms is put in the ground does it take to so change it that the plant cannot get it, if not used before the change takes place?"

Reply was made as follows:

Your questions cannot be answered very satisfactorily. Under favorable circumstances, most of the nitrogen of quick-acting fertilizers, used in the moderate quantities commonly employed, is taken up by the crops. In drought, the crop does not grow and the fertilizer remains unchanged in the soil. In warm and wet weather some nitrogen leaches out of the soil, and more or less according to the quantity of water which runs off in the drainage, and according to the kind of fertilizer.

In soils where there is free access of air for a good depth, the nitrogen of ammonia and of animal matters, like blood and tankage and of urine, passes more or less rapidly into nitric acid, provided there be present carbonate of lime or other alkaline body to form a nitrate, and provided also there be moderate moisture and a summer temperature. The nitrates thus formed, if not taken up by plants, are freely washed out of the soil by drainage water.

On the other hand, when stable-manure or leaf-mold or grass-roots slowly decay in a wet soil where access of air is imperfect and the temperature low, nitrogen of these and of nitrates, ammonia-salts, blood, etc., passes into a comparatively inactive form like that of swamp-muck. Virgin soil from forest or prairie contains most of its nitrogen in the latter form, which under cultivation (tillage, etc.), is slowly changed into nitrates.

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Land long left to grass and natural herbage or in wood, becomes richer in nitrogen; that under tillage, poorer. In the soil of forests there is said to be no nitrates. From drained lands, under tillage, there is considerable annual loss of nitrates, and drained lands in pasture and meadow also lose nitrogen as nitrates, although there is accumulation of nitrogen at the surface in the *humus* (decayed vegetable matter).

What is thus far written is the result of all the trustworthy investigations yet made known, but there is doubtless much more to be learned on these subjects than is now understood.

As to your question—would potatoes get more nitrogen from fertilizers if plaster were mixed with them, it may be said that so far as known, plaster would have no influence in case of nitrate of soda or sulphate of ammonia. When tankage, blood or urine begin to change in the soil under the moist warmth of spring time, they at first yield carbonate of ammonia—the same as one may smell in the air of a warm horse stable. The process of nitrification is checked by too much alkali. Plaster and carbonate of ammonia in the presence of water become carbonate of lime and sulphate of ammonia, neither of which oppose nitrification. It may be that this effect is favorable in the soil, especially when the fertilizer is sown in the hill or drill and not thoroughly mixed with earth, but water enough to *wet* the soil would be essential to the result.

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OBSERVATIONS ON THE GROWTH OF MAIZE CONTINUOUSLY ON THE SAME LAND.

In the years 1888 and 1889 a parcel of land containing 1⅛ acres was dressed with commercial fertilizers and planted to corn. The fertilizers and crops were analyzed, and the exhaustion or enrichment of the soil by the dressing and cropping accurately determined.

In 1890 this land was divided into four strips, each containing three tenths of an acre, and dressed as shown in the accompanying diagram. Corn was planted in drills which were four feet apart, and the stalks stood ten inches apart in the drill. The crop from each plot was separately weighed and analyzed. The same thing was repeated in 1891 and the results with full particulars of the method of planting, cultivating and harvesting are given in the Report of this station for 1891, pages 139, 149.

The same work has been repeated this year, 1892, with the same variety of seed, and under like conditions of planting, cultivating and harvesting as far as it was possible.

It is not necessary to rehearse these particulars, as they have been fully described in the Report already referred to.

The land was plowed May 5, 1892, planted May 24, the crop was cultivated June 11, July 2, and again late in July. It was cut Sept. 19, husked, weighed and harvested Oct. 25.

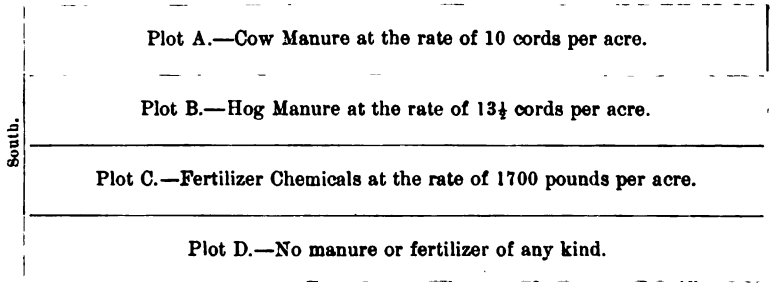
Plot A.—Cow Manure at the rate of 10 cords per acre.
Plot B.—Hog Manure at the rate of 13½ cords per acre.
South.
North.
Plot C.—Fertilizer Chemicals at the rate of 1700 pounds per acre.
Plot D.—No manure or fertilizer of any kind.

Table I presents the gross weight of field cured kernels, cobs and stover on the several plots.

Inasmuch as the kernels were air-dried on the cob, the weight of the latter in the field-cured condition could not be ascertained. The weight therefore of the kernels in the table is slightly higher and that of the cobs correspondingly lower than it should be. But the error is insignificant.

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TABLE I—GROSS YIELD OF THE PLOTS IN POUNDS PER ACRE.

	Plot A Cow manure.	Plot B Hog manure.	Plot C Chemicals.	Plot D No fertilizer.
Kernels	4858.7	5637.8	4864.4	2230.1
Cobs	515.8	688.0	714.7	237.4
Stover	5545.5	6274.2	4291.2	2662.5
	10920.0	12600.0	9870.3	3130.0

DRY SUBSTANCE OF THE CROPS IN POUNDS PER ACRE.

A strict comparison of yields can only be made on the water-free substance, since the field-cured crops contain large and variable quantities of water. Such a comparison is given below in Table II.

TABLE II.—DRY MATTER OF THE CROPS, POUNDS PER ACRE.

	In kernels.	In cobs.	In stover.	Total.
Plot A, cow manure	3018.3	460.7	3701.6	7180.6
Plot B, hog manure	3501.7	614.4	4116.5	8232.6
Plot C, fertilizer chemicals	3564.6	638.2	2858.7	7061.5
Plot D, no fertilizer	1592.3	212.0	1704.9	3509.2

YIELD OF EACH FOOD INGREDIENT, IN POUNDS PER ACRE.

From Table IV, given further on, and from the gross weights of the crops, has been calculated Table III, which shows how many pounds of each food ingredient were harvested in the kernels, the cobs and the stover separately, and how much in all together.

The cobs were not analyzed, but as their total weight was comparatively small, and as their composition is not likely to vary widely, the average composition of cobs, as determined in other analyses, was applied for the calculation.

DIFFERENCES IN CHEMICAL COMPOSITION OF CROP CAUSED BY DIFFERENCES IN FERTILIZATION.

Table IV gives the analyses of kernels and stover from the four plots, both in the field-cured and water-free condition. The latter serves best for comparison.

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Table III.—Yield of each Food Ingredient in Pounds per Acre.

	Plot A.				Plot B.				Plot C.				Plot D.			
	Kernels.	Cob.	Stover.	Total.	Kernels	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.
Water	1840.4	55.1	1843.9	3739.4	2136.1	73.6	2157.7	4367.4	1299.8	76.5	1432.4	2808.7	637.8	25.4	957.6	1620.8
Ash	46.1	7.2	237.3	290.6	54.7	9.6	267.3	331.6	49.1	10.0	170.7	229.8	20.5	3.3	90.8	114.6
Albuminoids	352.2	12.4	222.4	587.0	421.7	16.5	284.2	722.4	394.5	17.1	176.8	588.4	155.7	5.7	110.5	271.9
Fiber	46.6	155.3	1206.1	1408.0	54.1	207.1	1329.5	1590.7	61.8	215.1	953.9	1230.8	28.3	71.5	559.1	658.9
Nitrogen-free extract	2409.2	283.2	1978.1	4670.5	2779.4	377.8	2175.3	5332.5	2873.4	392 4	1516.1	4781.9	1309.3	130.3	918.5	2358.1
Fat	164.2	2.6	57.7	224.5	191.8	3.4	60.2	255.4	185.8	3.6	41.2	230.6	78.5	1.2	26.0	105.7
	4858.7	515.8	5545.5	10920.0	5637.8	688.0	6274.2	12600.0	4864.4	714.7	4291.1	9870.2	2230.1	237.4	2662.5	5130.0

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TABLE IV.—ANALYSES OF FIELD-CURED MAIZE KERNELS AND STOVER FROM PLOTS A, B, C, D.

PLOT.	ANALYSIS OF FIELD-CURED MAIZE.						ANALYSIS, CALCULATED WATER-FREE.				
	Water.	Ash.	Albumin-oids.	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.	Ash.	Albumin-oids.	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.
KERNELS.											
A.	37.87	.95	7.25	.96	49.59	3.38	1.53	11.67	1.54	79.83	5.43
B.	37.89	.97	7.48	.96	49.30	3.40	1.56	12.04	1.55	79.38	5.47
C.	26 72	1.01	8.11	1.27	59.07	3.82	1.37	11.05	1.74	80.62	5.22
D.	28.60	.92	6.98	1.27	58.71	3.52	1.29	9.80	1.78	82.21	4.92
STOVER.											
A.	33.25	4.28	4.01	21.75	35.67	1.04	6.40	6.00	32.60	53.45	1.55
B.	34.39	4.26	4.53	21.19	34.67	.96	6.50	6.93	32.28	52.82	1.47
C.	33.38	3.98	4 12	22.23	35.33	.96	5.97	6.18	33.36	53.05	1.44
D.	35.97	3.41	4.15	20.99	34.50	.98	5.32	6.48	32.77	53.90	1.53

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Quantities of Nitrogen, Phosphoric Acid and Potash applied in the Manure or Fertilizer and Removed by the Crop.

The manure used, which was made from the same kind of feed and of animals as in 1890, was not analyzed again in 1891 or 1892, but was assumed to have the same composition as in the previous year.

In Table V are given, first, the total quantities of nitrogen, phosphoric acid and potash which have been applied to the land in the years 1888, 1889, 1890 and 1891, in excess of the quantities removed by the crops of those years, then second, the quantities applied in 1892, third, the quantities removed by the maize crop of 1892, and fourth, the quantities of these ingredients added in five years in excess of what was removed by the five crops, marked [+], or the quantities of each removed by the crops in excess of what was supplied in fertilizers, marked [−].

The larger quantity of phosphoric acid and smaller quantity of potash in excess on Plot B as compared with A is explained by differences in the feed of the cattle which made the manure used. The cows ate large quantities of hay and stover, relatively rich in potash while the hogs had phosphates in the bones which came in garbage, but potash in the food was relatively small in quantity.

So heavy an application as 13½ cords per acre of this hog manure while supplying nitrogen and phosphoric acid in very great excess of the quantity which the crop removes, supplied this year less potash than the corn crop removed.

Yields of "Shelled Corn," and Percentage Composition of Dry Matter for Five Years.

Table VI shows the largest crops of dry matter, reckoned to the acre, which were harvested in 1888 and 1889 and their percentage composition, together with all crops from drills in 1890 and from Plots A, B, C, D in 1891 and 1892 calculated to an acre. The rows were four feet apart in all four years.

The plots marked A were on cow manure, B were on hog manure, C on commercial fertilizers, and D had no fertilizer in the years 1890, 1891 and 1892.

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TABLE V.—ENRICHMENT OR IMPOVERISHMENT OF SOIL BY FIVE YEARS' MANURING AND CROPPING.

	Cow Manure. Plot A.			Hog Manure. Plot B.			Fertilizer Chemicals. Plot C.			No Fertilizer. Plot D.		
	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.
After four years' cropping.	+302.1	+340.2.	+330.5	+550.7	+1219.9	+72.3	+106.2	+403.8	+92.2	−183.6	+97.1	−10.8
Applied in 1892.....	286.3	136.4	204.5	419.9	586.5	72.4	172.0	162.0	69.0	00.0	00.0	00.0
Taken off in Crop of 1892.	93.9	29.6	94.6	115.6	40.0	101.3	94.1	29.1	65.3	43.5	14.6	18.5
Leaving in excess (+) or deficiency (−) after five years' cropping.....	+494.5	+447.0	+440.4	+855.0	+1766.4	+43.4	+184.1	+536.7	+95.9	−227.1	+82.5	−29.3

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TABLE VI.—YIELD OF DRY MATTER AND "SHELLED CORN" PER ACRE FOR FOUR YEARS AND COMPOSITION OF DRY MATTER.

	Year.	Distance of Planting.	Yield of Dry Matter per Acre.	Bushels of Sound Shelled Corn.	Percentage Composition of Dry Matter				
					Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
Fertilized alike	1888	Stalks 12 inches apart,	7350	75	3.3	7.8	19.4	66.1	3.4
	1888	" 6 " "	7980						
	1889	" 12 " "	6144	60	3.5	6.1	21.7	69.7	3.0
	1889	" 6 " "	6352						
On Cow Manure	1890A	" 10 " "	9014	91	4.0	7.9	19.8	65.7	2.6
On Hog Manure	1890B	" 10 " "	9436	97	4.2	8.0	19.6	65.5	2.7
On Fertilizer Chemicals	1890C	" 10 " "	8070	87	3.9	8.0	21.2	64.4	2.5
No Manure or Fertilizer	1890D	" 10 " "	6626	51	3.8	6.2	20.7	66.7	2.6
On Cow Manure	1891A	" 12 " "	8176	103	3 2	7.5	15.5	70.2	3.6
On Hog Manure	1891B	" 12 " "	7599	89	3.3	7.6	16.2	69.3	3.6
On Fertilizer Chemicals	1891C	" 12 " "	6708	70	3.2	6.4	18.5	68.8	3.1
No Manure or Fertilizer	1891D	" 12 " "	5391	60	3.1	6.0	17.4	70.2	3.3
On Cow Manure	1892A	" 12 " "	7181	72	4.0	8.2	19.6	65.1	3.1
On Hog Manure	1892B	" 12 " "	8233	84	4.0	8.8	19.3	64.8	3.1
On Fertilizer Chemicals	1892C	" 12 " "	7062	86	3.2	8.3	17.5	67.8	3.2
No Manure or Fertilizer	1892D	" 12 " "	3509	38	3.3	7.7	18.8	67.2	3.0

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As it is customary to judge of a maize crop by the yield of "shelled corn" in bushels, the yields have also been calculated in this way with the results given in the fourth column of the table. In this calculation twenty per cent. has been added to the weight of water-free kernels for the water in corn cured enough to shell and 50 pounds have been assumed as the weight of such shelled corn per bushel.

Further discussion of the results here tabulated is reserved till more data are gathered as each year's cropping adds to their interest and value.

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ANALYSES OF CREAMERY AND PRIVATE DAIRY BUTTER.

The samples whose analyses are given below were taken from the Exhibit made at the meeting of the Connecticut Dairymen's Association, at Hartford, Jan. 19, 1892.

They represent all the butter which was there exhibited.

The samples were scored by the judges on the following scale:

Perfection requires,	Flavor	50 points.
	Grain	25
	Color	15
	Salt	5
	Package or appearance	5
		100

The scores and chemical analyses are given on page 131.

A sample of Ayrshire butter not entered in competition, had the following composition:

Water	9.12
Salt	3.52
Curd	1.30
Fat	86.06
	100.00

From these analyses, with those given in the Report for 1891, numbering 17 in all, is calculated the average composition of creamery butter. From the 22 analyses of Private Dairy butter is also calculated its average composition as follows:

	Creamery Butter.		Private Dairy Butter.	
	Average.	Range of Composition.	Average.	Range of Composition.
Water	10.08	6.5—12.8	10.87	8.2—15.2
Salt	3.17	2.1— 4.8	3.39	.7— 2.5
Curd	1.14	.9— 1.6	1.29	1.2— 7.8
Fat	85.61	82.0—88.4	84.45	80.7—87.7
	100.00		100.00	

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Creamery Butters.

Score — Number:	2	1	14	13	9	12	6	4	11	10	8
Flavor	45.6	45.2	47.3	45.9	45.6	45.0	45.1	45 3	45.1	45.7	43.6
Grain	23.6	27.0	23.0	22 0	23.1	22.0	22 3	21.9	21.8	19.7	22.7
Color	14.5	13.0	13.0	14.2	12.7	14.0	13.4	13.4	13 5	13.4	12.0
Salt	4.8	4.0	4.5	4.0	4.7	4.5	4.4	4.5	4.4	4.6	4.4
Package	4.8	4 0	4.6	4.7	4.5	4 5	4.7	4.4	4.6	4.6	4.7
	93.3	93.2	92.4	90.8	90.6	90.0	89.7	89.5	89.4	88.0	87.4
Chemical Analysis:											
Water	11.49	10.60	9.18	12.22	11.56	9.04	10.33	12.83	8.55	9.96	10.97
Salt	3.95	3.70	3.72	4.77	2.94	2.37	2.19	3 99	2.23	3.28	3.35
Curd	1.02	1.24	1.13	1.06	1.08	1.10	1.03	1.12	1.48	1.37	1.12
Fat	83.54	84.46	85.97	81.95	84.42	87.49	86.45	82.06	87.74	85.39	84.56
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Private Dairy Butters.

Score — Number:	1	9	5	6	12	7	11	3	2	4	8
Flavor	45.0	44.6	41.6	40.4	44.0	43.0	36.0	36 0	36.6	35.0	31.0
Grain	23.4	23.6	21.6	22.2	19.0	21.6	23.8	24.0	22 2	21.6	16.8
Color	14.4	14.0	14.0	13.6	12 8	10.4	14.8	12.2	14 8	9.2	11.6
Salt	4.6	4.6	4.6	3.8	4.4	4.0	3.4	4.4	3.4	5.0	4.8
Package	4.6	4.8	4.8	4.8	4.2	4.8	3.8	5.0	4.4	4.2	4.4
	92.0	91.6	86.6	84.8	84.4	83.8	81.8	81.6	81.4	75.0	68.6
Chemical Analysis:											
Water	11.37	9.56	8.62	12.44	8.24	13.33	15.23	9.91	10.94	12.10	8.64
Salt	1.90	2.38	3.46	4.22	3.96	2.55	3.44	2.72	3.07	1.81	3.19
Curd	1.03	.70	1.81	.90	1.27	1.55	.99	.80	.92	1.02	1.00
Fat	85.70	87.36	86.11	82.44	86.53	82.57	80.34	86.57	85.07	85 07	87.17
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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PROTEIDS OF THE FLAXSEED.

Abstract of a Paper published in the American Chemical Journal, vol. 14, pp. 629–661.

By Thomas B. Osborne.

The extensive use, as a cattle-food, of flaxseed partly freed from oil by expression or extraction, under the name of linseed-meal, renders desirable as complete a knowledge as possible of its chemical composition. As the chief value of this feed is due to the large amount of albuminoids contained in it, a careful study of these bodies is important from a practical as well as from a scientific standpoint.

Although extended search has been made, the writer has nowhere found any investigation relating to the proteids contained in this seed. A study of these proteids was accordingly undertaken, the results of which are here briefly stated.

Ground flaxseed, freed from oil by extraction with benzine or ether, yields to both water and solutions of sodium chloride, a large proportion of its proteid matter. After complete exhaustion with water, 10-per cent. sodium chloride brine extracts a further portion of proteids. Neither water nor salt solution removes all the proteids, for there always remains in the extracted residue more or less proteid soluble in dilute potash-water, as well as some nitrogenous substance, probably proteid, which the alkali fails to remove.

Flax Globulin.—Of the substance soluble in water or sodium chloride solution as well as of that taken up directly by dilute potash-solution, a very large part is a globulin which has been separated in a crystalline form and prepared, it is believed, in a state of purity.

The composition of this globulin is shown by the following analyses of ten distinct preparations obtained under different conditions.

Flax Globulin.

Extracted by water at 20°.

	1	2	3
Carbon	51.42	....	51.69
Hydrogen	7.06	....	....
Nitrogen	18.61	18.74	18.70
Sulphur	0.76	....	0.73
Oxygen	22.15	....	....
	100.00		

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Extracted by salt solution.

	After water at 20°.	After water at 40°.	Direct.	Direct.
	4	5	6	7
Carbon	51.17	51.46	51.32	51.59
Hydrogen	6.90	6.94	6.87	7.27
Nitrogen	18.95	18.41	18.60	18.34
Sulphur	0.88	0.99	0.82	} 22.80
Oxygen	22.10	22.29	22.39	
	100.00	100.00	100.00	100.00

Extracted by $\frac{1}{10}$ per cent. potash solution.

	Prep. 6 dissolved in potash and precipitated.			Average.
	8	9	10	1-10
Carbon	51.67	51.53	51.50	51.48
Hydrogen	6.92	6.94	6.95	6.94
Nitrogen	18.79	18.45	18.37	18.60
Sulphur	0.82	0.73	} 23.18	0.81
Oxygen	21.80	22.35		22.17
	100.00	100.00	100.00	100.00

These results agree so closely with the analyses of the globulin obtained from squash-seed, that there can be no doubt that the two proteids are identical. This agreement is shown by the following figures:

	Flax Globulin.	Squash-seed Globulin.		
	Osborne.	Chittenden and Hartwell.*	Ritthausen.†	Grübler.‡
Carbon	51.48	51.60	51.61	51.48
Hydrogen	6.94	6.97	7.00	6.76
Nitrogen	18.60	18.80	....	18.14
Sulphur	0.81	1.01	....	0.96
Oxygen	22.17	21.62	....	22.66
	100.00	100.00		100.00

In pure distilled water at 20° this proteid, whether separated from solution by cooling or by dialysis, is wholly insoluble, while in water at 40° it is very slightly soluble. In 10 per cent. sodium chloride solution it is mostly soluble, a part (Weyl's "albuminate") generally remaining undissolved, which, however, dissolves readily on warming the solution and partly separates, on cooling, in very finely developed crystals. In glycerin diluted with water the substance separated by dialysis is wholly insoluble, either at 20° or 40°; while the substance separated from a warm sodium chloride solution is largely soluble at 20°.

* J. Physiol. 11, 440. † J. prakt. Chem. 25, 136. ‡ J. prakt. Chem. 44, 369.

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It dissolves easily in $\frac{2}{10}$ per cent. potash solution and is thrown down by exact neutralization, without change of composition or properties.

This Globulin, when separated by dialysis, dissolves in 10 per cent. sodium chloride brine to a solution which on heating gives successively three minute coagula of other globulins at 67°, 80° and 88° respectively.

Saturation with sodium chloride gives a small precipitate which consists partly of these other globulins, for the filtrate from this precipitate, when diluted so as to contain 10-per cent. of sodium chloride, yields but a trace of coagulum on heating to boiling, while the precipitate itself dissolved in 10-per cent. sodium chloride yields a solution which coagulates at the various tempertures observed in the solution before saturation.

Saturation with ammonium sulphate and also with magnesium sulphate completely precipitates this proteid from its solutions.

Flax Albumin.—After separating the globulin by dialysis and filtration, the clear liquid can be heated to boiling without producing a coagulum, but if concentrated to a small volume a coagulation gradually takes place. If the dialysed liquid be treated with about 2 per cent. of sodium chloride, and a little hydrochloric acid be added, a precipitate is produced consisting of a proteid resembling an albumin in its solubility in water but like a globulin in that, when precipitated by salt and acid, it forms an acid compound soluble in water nearly or wholly free from salts. On the other hand it is thrown out of such solutions upon neutralization with sodium carbonate.

FLAX-ALBUMIN.

Carbon	50.14
Hydrogen	6.72
Nitrogen	17.54
Sulphur } Oxygen }	25.70
	100.00

Similar substances to the foregoing were found in the extracts of the maize kernel and in Chittenden and Osborne's paper* on the proteids of that seed, were described as albumins.

Flax Proteose.—Together with this albumin there is precipitated more or less proteose, resembling closely in composition the deuterovitellose obtained by Chittenden and Hartwell from the crystallized proteid of the squash-seed.† After separating

* Am. Chem. Jour., 13, 453, 529; 14, 20. † J. Physiology, 11, 435.

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the coagulable proteids by concentrating their solution to a small volume and filtering, there was always found in the filtrate more or less proteoses and peptones which were separated from solution by precipitation with alcohol.

The mixture of these substances was very readily soluble in water to a solution which, when saturated with ammqnium sulphate while hot, and filtered, gave a strong red biuret-reaction, and no precipitate with copper sulphate, thus showing the presence of peptones. This was observed in all of the five preparations examined. The aqueous solution was precipitated by copper sulphate, gave a precipitate with nitric acid which dissolved on heating and reappeared on cooling, and a precipitate with ammonium sulphate. These reactions show the presence of proteoses.

The composition of the proteose and that of the deuterovitellose, obtained by Chittenden and Hartwell, by artificial digestion of the squash-seed globulin with pepsin, are as follows:

	Flaxseed Proteose.	Squash vitellose.	
Carbon	49.98	50.42	49.27
Hydrogen	6.95	6.74	6.70
Nitrogen	18.78	18.43	18.78
Sulphur } Oxygen }	24.29	24.41	25.25
	100.00	100.00	100.00

The composition of the peptone and that of a small amount of proteid extracted by potash-water after exhausting flax-meal with sodium chloride solution, could not be determined.

The Amount of the various Proteids separated from the Flaxseed.

The results of this investigation, thus far recorded, show that the extracts of the flaxseed contain a globulin precipitable by dialysis; a proteid, resembling both globulin and albumin, precipitable by long continued heating at 100°, as well as by sodium chloride in the presence of acid; proteose and peptone-like bodies, and a proteid not extracted by sodium chloride solution, but soluble in dilute potash-water.

All attempts to determine the amounts of these various substances failed because of their change, while in solution, into non-proteid bodies. The relative amounts of the various proteids that

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could be separated were very variable and it is almost certain that the more soluble forms were largely, if not wholly, derived from the globulin in consequence of its alteration during extraction and separation. These operations were in all cases greatly prolonged on account of the gum contained in the seed, which rendered filtration extremely difficult and slow. Putrefaction, however, was entirely prevented by the use of thymol. Numerous attempts were made to determine the total proteid-nitrogen in the seed, but in no case did the nitrogen extracted and recovered in the proteid precipitates, added to that in the extracted residue, equal the total nitrogen contained in the flaxseed meal.

This may be illustrated by the following figures: 100 grams of flaxseed meal, containing 8.40 per cent. of nitrogen, were extracted, first with water, then with 10-per cent. sodium chloride solution and, finally, with $\frac{2}{10}$ per cent. potash-water. Out of 8.4 grams of total nitrogen 0.4255 gram remained in the residue of the seed, showing that 94.94 per cent. of the total nitrogen was soluble in the reagents employed. The nitrogen extracted by potash-water amounted to 2.15 per cent. of the total, so that by water and by sodium chloride solution 92.79 per cent. of the total nitrogen was extracted. The nitrogen recovered from these solutions amounted to but 38.59 per cent. of the total, accordingly the nitrogen lost equaled 4.5528 grams, or 54.2 per cent. This loss must have been due either to the presence of non-proteid nitrogenous substances, or to a decomposition of the proteid matter into diffusible compounds.

A careful examination of the seed failed to detect any non-proteid nitrogenous compounds, but it was found that during dialysis of solutions of the proteids here described, nitrogenous substances continuously and slowly separated which gave none of the usual proteid reactions. In this way a very large proportion of the proteid nitrogen was lost.

When flaxseed meal was directly extracted with dilute potash-water, 32.74 per cent. of the meal was obtained in the form of a precipitated proteid, on neutralizing the solution. The insoluble residue of the meal further yielded nitrogen equivalent to 8.0 per cent. of proteid reckoned as globulin.* The nitrogen of the neutralization precipitate was equivalent to 29.4 per cent. of globulin. The sum of these would be 37.4 per cent. of the meal.

The results of this investigation, already given, show that the

* With 18.6 per cent. of nitrogen.

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globulin and the body extracted by dilute potash are the only proteids found in the extract which are precipitated from an alkaline solution on neutralization. Therefore these two proteids must be the only ones contained in the precipitate. If we assume that the proteids in the flax-seed have, on the average, 18 per cent. of nitrogen, the meal extracted in this case would contain 48.0 per cent. of proteids. The 37.4 per cent. thus accounted for amounts to 78.0 per cent. of the total proteids.

This would indicate that the globulin formed at least four-fifths of the proteid matter of the seed.

It is exceedingly desirable to determine as accurately as possible the amount of each proteid contained in the seed, and to know exactly its nitrogen content so that an accurate factor may be obtained for calculating the proportion of proteids from the nitrogen found.

It is evident from the preceding statements that it is impossible to say exactly what this factor should be for flax-seed, but a pretty close approximation can be made—one at least far more accurate than the factor at present in use based on a content of 16 per cent. of nitrogen. It has been shown that about 93 per cent. of the nitrogen of the seed is extracted by salt solutions. This nitrogen belongs chiefly to the globulin which contains 18.6 per cent. of nitrogen. The albumin-like body was found to contain 17.5 per cent. of nitrogen, and the proteose prepared in a pure state contained in one case 18.78 per cent. and in another 18.33 per cent. of nitrogen. If, then, we assume the proteids to contain collectively an average of 18.00 per cent. of nitrogen we will not be very far from the truth. The factor then for flax-seed would be 5.55 instead of 6.25, and, for a sample of linseed meal containing 7 per cent. of nitrogen, would give a content of proteid of 38.85 per cent. instead of 43.75—a difference of very considerable magnitude.

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CRYSTALLIZED VEGETABLE PROTEIDS.

Abstract of a Paper published in the American Chemical Journal, vol. 14, pp. 662–689.

By Thomas B. Osborne.

The existence of crystallised proteids in seeds was pointed out by Hartig in 1855. Four years later, Maschke obtained hexagonal plates of proteid matter by extracting Brazil-nuts with water heated to 40°–50° and evaporating the filtered extract at 40°. Nägeli* investigated the crystal-like forms from the Brazil-nut as well as the artificially produced crystals of Maschke and concluded that they differed in some respects from true crystals. He therefore designated them as "crystalloids."

Sachsse† following Maschke's method, and also by precipitating the aqueous extract with carbonic acid, obtained several preparations of proteid from the Brazil-nut, which he analysed. These preparations were, however, not composed of distinct crystals, but of small discs.

Schmiedeberg‡ obtained crystallized products by treating the aqueous extract of the Brazil-nut with carbon dioxide, washing the precipitated proteid, digesting the precipitate with magnesia suspended in water at 35°, filtering and evaporating at the same temperature. These crystals he considered to be a compound of the proteid with magnesia.

Drechsel‖ obtained crystals, presumably hexagonal plates, by submitting the solution containing the "magnesia compound," prepared as Schmiedeberg suggested, to dialysis in a vessel containing alcohol.

Drechsel afterwards obtained finely developed crystals by allowing a warm sodium chloride solution saturated with the proteid of the Brazil-nut to cool slowly.§

At Drechsel's suggestion Grübler applied this method with some modification to the proteids of squash-seed, and made a large number of preparations of perfectly formed octahedral crystals whose properties and composition he described at length.¶

* Botanische Mittheilungen (München, 1863), vol. 1.

† Die Farbstoffe, Kohlenhydrate und Proteinsubstanzen (Leipzig, 1877), p. 315.

‡ Ztschr. physiol. Chem., **1**, 205.

‖ J. prakt. Chem., **19**, 331.

§ Grübler: *cf. ibid.*, **23**, 100.

¶ J. prakt. Chem., **23**, 97.

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Ritthausen* obtained crystallised preparations from the castor-bean, hemp-seed, and sesame-seed, which separated from a warm sodium chloride solution on cooling in the form of regular octahedrons. The composition and properties of the crystals obtained from the hemp-seed and castor-bean he described in a subsequent paper.†

The writer next prepared rhombohedral and octahedral crystals from the oat-kernel by cooling a warm dilute sodium chloride solution saturated with the proteid.‡

The writer has also obtained octahedral crystals from flax-seed by extracting with a solution of sodium chloride and dialysing the filtered extract; the proteid separating in well-formed crystals as the salts were removed.‖

The fact that these proteid substances can be artificially crystallised is not only interesting in itself, but is important as presumably furnishing a means for making preparations of undoubted purity which will afford a sure basis for further study of their properties. The contradictory statements made by the various investigators, not only in regard to properties and composition of these bodies but also in respect to the value of the methods of solution and separation which have been employed hitherto, render an exact knowledge of all the facts relating to these substances a matter of the highest scientific and practical importance.

An examination of the literature indicates that definitely crystallised preparations from the Brazil-nut have never been analyzed, and also shows that the published analyses do not agree sufficiently to fix the composition of the substance.

Ritthausen's observations on the properties of the crystallised proteids of the hemp-seed and castor-bean indicate that they are closely related to, if not identical with, the body obtained by Grübler from the squash-seed; yet the results of Ritthausen's analyses differ widely from those first made by Grübler.

The composition of the crystallised proteid of the squash-seed has been fixed within narrower limits by the analyses of Chittenden and Hartwell,§ Ritthausen,¶ and Grübler.** It seemed desirable, therefore, that the composition and properties of the

* J. prakt. Chem., **23**, 481.
† *Ibid.*, **25**, 130.
‡ Report Conn. Agri. Expt. Station 1890, and Am. Chem. J., **13**, 408; **14**, 212.
‖ Am. Chem. J., **14**, 329, 629.
§ J. of Physiology, **11**, 435.
¶ J. prakt. Chem., **25**, 137.
** *Ibid.*, **44**, 369.

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various crystallised proteids should be investigated anew in order to determine the relations of these substances.

As the writer has already prepared crystallised products from the oat-kernel and flax-seed, he determined to reinvestigate the similar bodies obtainable from the Brazil-nut, hemp-seed, castor-bean and squash-seed, and a summary of the results of this investigation are here given.

I. The crystallised globulins of the Brazil-nut and of the oat-kernel are distinct substances. Their composition is seen from the following analyses:

	Brazil-nut.	Oat-kernel.
Carbon	52.18	52.18
Hydrogen	6.92	7.05
Nitrogen	18.30	17.99
Sulphur	1.06	0.53
Oxygen	21.54	22.34
	100.00	100.00

If the differences in nitrogen- and sulphur-content are not perhaps sufficient to distinguish these two proteids, their reactions prove them to be distinct, for when prepared in the same manner they are unlike in many respects.

In distilled water heated to 60° the globulin of the Brazil-nut is wholly insoluble, while that of the oat-kernel dissolves completely. Saturation of a 10-per cent. sodium chloride solution of these substances with salt almost completely precipitates the proteid of the oat-kernel, that of the Brazil-nut being unaffected. Saturation of similar solutions with magnesium sulphate precipitates but little of the Brazil-nut, but all of the oat-globulin. When solutions of these bodies in 10-per cent. sodium chloride brine are heated, the Brazil-nut globulin begins to separate at 70°, a flocculent coagulum forming at 84°, which increases on raising the temperature to boiling, the proteid being largely, but not wholly, precipitated. The globulin of the oat-kernel, on the other hand, is not coagulated at all by boiling.

II. The crystalline globulins of the hemp-seed, castor-bean, squash-seed, and flax-seed are almost identical in composition, as may be seen by comparing the analyses:

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	Hemp-seed.	Castor-Bean.	Squash-seed.	Flax-seed.
Carbon	51.28	51.31	51.66	51.48
Hydrogen	6.84	6.97	6.89	6.94
Nitrogen	18.84	18.75	18.51	18.60
Sulphur	0.87	0.76	0.88	0.81
Oxygen	22.17	22.21	22.06	22.17
	100.00	100.00	100.00	100.00

The carbon content of the hemp and castor globulins is less than that of the squash and flax globulins by about 0.25 per cent., a difference too slight to have importance, if it were not constant for almost all the preparations analysed. The deportment of these globulins toward reagents is also very similar, but in this respect the hemp and castor globulins show slight differences from those of the squash and flax-seed; the two former are, however, almost exactly alike, and the two latter likewise closely agree together. The following table plainly exhibits these relations:

HEAT COAGULATIONS.

	Hemp.	Castor.	Squash.	Flax.
Turbidity	75°	87°	--	67°
Flocks	86	89	--	80
Filtered,				
Turbidity	88	87	87	90
Flocks	95	95	95	96
Filtered,				
Boiling	no coagulum.	ditto.	ditto.	ditto.
Filtered and acetic acid added,	heavy pp.	ditto.	ditto.	ditto.

SOLUBILITY.*

	Hemp.†		Castor.		Squash.	Flax.	
	A.	B.	A.	B.	A. B.	A.	B.
H_2O at 20°	P.	I.	P.	I.	I.	I.	I.
H_2O at 40°	S.	I.	S.	I.	I.	P.	I.
Glycerine at 20°	S.	I.	S.	I.	I.	P.	I.
Glycerine at 50°	S.	I.	S.	I.	I.	P.	I.
10-per cent. NaCl sol. diluted	Pp.	Pp.	Pp.	Pp.	Pp.	Pp.	Pp.
Saturated with NaCl	T. pp.	T. pp.	T. pp.	T. pp.	No Pp.	V.	V.
Saturated with $MgSO_4$	C. pp.	C. pp.	C. pp.	C. pp.	C. pp.	C. pp.	C. pp.

* P. = Partly soluble; I. = Insoluble; S. = Soluble; Pp. = Precipitate; T. pp. = Trace of precipitate; C. pp. = Completely precipitated; V. = Very little precipitate.

† A. indicates preparations obtained by cooling warm salt solutions; B. those obtained by dialysis.

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The proteids coagulating at the lower temperature are traces of other globulins imperfectly separated from the crystalline globulin. The coagulum separating at the higher temperature is undoubtedly a part of the crystalline globulin which is broken up when heated to this temperature. It is seen that the temperature at which this coagulum separates is the same for all four substances.

In solubility these four proteids are very nearly alike, the most noticeable difference being that the globulins of the hemp-seed and castor-bean, when separated from a warm sodium chloride solution, are soluble in water and diluted glycerin, while the other preparations, both of this substance and the globulins of other seeds, are insoluble under the same conditions.

Of the flax-seed globulin separated from a warm salt solution, a little dissolves in water at 40°.

The small precipitate obtained by saturating a sodium chloride solution of the globulins with salt, undoubtedly consists mostly of traces of other globulins.

It is at present impossible to assert that these four globulins are the same, but since differences exist between different preparations of globulin from the same seed as great as those found among the globulins of these different seeds, the writer is disposed to consider these four globulins as identical.

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PROTEIDS OF THE WHEAT-KERNEL.

Abstract of a Paper nearly ready for publication.

By Thomas B. Osborne and Clark L. Voorhees.

The proteids contained in the wheat-kernel are :

I. A *Globulin* belonging to the class of vegetable vitellins, soluble in saline solutions, precipitated therefrom by dilution and also by saturation with magnesium sulphate or ammonium sulphate but not by saturation with sodium chloride. Partly precipitated by boiling, but not coagulated at temperatures below 100°. The wheat-kernel contains between 0.6 and 0.7 per cent. of this globulin. When dried at 110° its composition was found to be as follows :

Wheat Globulin.

Carbon	51.03
Hydrogen	6.85
Nitrogen	18.39
Sulphur	0.69
Oxygen	23.04
	100.00

II. An *Albumin*, coagulating at 52°, which differs from animal albumin in being precipitated on saturating its solutions with sodium chloride or with magnesium sulphate, but not precipitated on completely removing salts by dialysis in distilled water. It was found to form between 0.3 and 0.4 per cent. of the wheat-kernel and to have the following composition when separated from solution in the coagulated form by heating to 60° C.

Wheat Albumin.

Carbon	53.02
Hydrogen	6.84
Nitrogen	16.80
Sulphur	1.28
Oxygen	22.06
	100.00

III. A *Proteose*, precipitated (after removing the globulin by dialysis, and the albumin by coagulation), by saturating the solution with sodium chloride or by adding 20 per cent. of sodium chloride and acidifying with acetic acid. This body was not analysed in its unaltered form. On concentrating its solutions

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by boiling, a coagulum was gradually developed which formed about 0.3 per cent. of the wheat-kernel and had the following composition:

COAGULUM.	
Carbon	51.86
Hydrogen	6.82
Nitrogen	17.32
Sulphur, Oxygen	24.00
	100.00

The solution filtered from the substance just described, still contained a proteose-like body which was not obtainable in a pure state. Its amount could only be roughly estimated by precipitating the concentrated filtrate from the preceding substance with alcohol, and multiplying the nitrogen contained in the precipitate by 6.25. The amount of this proteose was from 0.2 to 0.4 per cent. of the seed. Both these substances are unquestionably derivatives of some other proteid in the seed, presumably the proteose first mentioned.

IV. *Gliadin*, soluble in dilute alcohol and forming about 4.25 per cent. of the seed. It has the following composition:

GLIADIN.	
Carbon	52.72
Hydrogen	6.86
Nitrogen	17.66
Sulphur	1.14
Oxygen	21.62
	100.00

This is the proteid called gliadin by Taddei and plant-gelatin by Dumas and Cahours. Mixed with impurities or altered to a greater or less extent by the processes of separation, it has been described by Ritthausen under the names of gluten-fibrin, plant-gelatin, or gliadin, and mucedin, and by Martin has been termed insoluble phytalbumose. The mucin of Berzelius and of De Saussure were impure preparations consisting chiefly of this proteid. It is soluble in distilled water to opalescent solutions which are precipitated by adding a very little sodium chloride. It is completely insoluble in absolute alcohol, but slightly soluble in 90-per cent. alcohol, and very soluble in 70 to 80-per cent. alcohol and is precipitated from these solutions on adding either much

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water or strong alcohol, especially in the presence of much salts. Soluble in very dilute acids and alkalies and precipitated from these solutions by neutralization, unchanged in properties and composition. This proteid is one on which the formation of gluten largely depends.

V. *Glutenin*, a proteid insoluble in water, saline solutions and dilute alcohol which forms the remainder of the proteids of the wheat-kernel, generally about 4. to 4.5 per cent. of the seed. This substance is soluble in dilute acids and alkalies and is precipitated from such solutions by neutralization. Dissolved in $\frac{2}{10}$ per cent. potash water, precipitated by neutralization and, after thorough extraction with alcohol and ether, again dissolved in potash water, the solution filtered *clear*, precipitated by neutralization and dried at 110°, it has the following composition :

GLUTENIN.

Carbon	52.34
Hydrogen	6.83
Nitrogen	17.49
Sulphur	1.08
Oxygen	22.26
	100.00

Unless prepared as above described the impurities are not removed and the analyses are discordant. This proteid was first described by Taddei under the name of zymom. Liebig as well as Dumas and Cahours named it plant-fibrin. Ritthausen called it gluten-casein, Weyl and Bischoff considered it to be an albuminate form of a myosin-like globulin. Martin named it gluten-fibrin and likewise considered it to be an albuminate form of a myosin-like globulin.

VI. Wheat-gluten is composed of gliadin and glutenin. Both these proteids are necessary for its formation. The gliadin with water forms a sticky medium, which by the presence of salts is prevented from becoming wholly soluble. This medium binds together the particles of flour, rendering the dough and gluten tough and coherent. The glutenin imparts solidity to the gluten, evidently forming a nucleus to which the gliadin adheres and from which it is consequently not washed away by water. Gliadin and starch mixed in the proportion of 1 to 10 form a dough, but yield no gluten, the gliadin being washed away with the starch. The flour freed from gliadin gives no gluten, there being no bind-

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ing material to hold the particles together, so that they may be brought into a coherent mass.

Soluble salts are also necessary in forming gluten, as in distilled water gliadin is readily soluble. In water containing salts it forms a very viscid semi-fluid mass, which has great power to bind together the particles of flour. The mineral constituents of the seeds are sufficient to accomplish this purpose, for gluten can be obtained by washing a dough with distilled water.

VII. No ferment action occurs in the formation of gluten, for its constituents are found in the flour having the same properties and composition as in the gluten, even under those conditions which would be supposed to completely remove antecedent proteids, or to prevent ferment action. All the phenomena which have been attributed to ferment action are explained by the properties of the proteids themselves, as they exist in the seed and in the gluten.

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ANALYSES OF FEEDING STUFFS.

The following analyses of feeding stuffs have been made at this Station within the last two years:

Cotton Seed Meal.

3110. Sampled from stock on sale in Middletown.

3148. Sampled and sent by T. J. Stroud.

3409. Made by Charlotte Oil & Fertilizer Co., Charlotte, N. C. Sent by H. S. Lathrop, Suffield.

3726. Sold by Thomas A. Shaw, Hartford. Sent by W. H. Olcott, South Manchester.

3408. "Cotton Seed Feed." Made by the Charlotte Oil & Fertilizer Co. "Claimed to be a complete food for cattle and sheep. Twenty-five pounds a day said to be sufficient for a cow or steer with no other food. Price one-half that of cotton seed meal." Sent by H. S. Lathrop, Suffield.

Linseed Meal.

3359. Made by Detroit Linseed Oil Works. Sent by T. A. Stanley, New Britain. Cost in 1891, $24.00 per ton in car lots delivered in Connecticut.

3718. The same delivered in 1892. Cost $24.90 per ton in car lots delivered.

3142. Marked "Pure Ground Oil Cake." Bought of Taylor & Richards, Westport. Sampled by E. C. Birge, Southport. Cost $30.00 in 1891.

3143. The same, but marked "Linseed Meal." Cost $30.00 in 1891.

3725. Bought of Thomas A. Shaw, Hartford. Sent by W. H. Olcott, South Manchester. Cost $31.00 in January, 1893.

Cream Gluten.

3363. Made by Chas. Pope Glucose Co., Geneva, Ill. Sold by Smith, Northam & Robinson, Hartford, September, 1891. Sent by T. J. Stroud, Shaker Station.

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Gluten Feed and Gluten Meal.

3536. Gluten Meal. Bought in East Hartford. Sent by W. H. Olcott, South Manchester. Cost by single bag (100 pounds), $1.40.

3716. Buffalo Gluten Feed. Sent by T. A. Stanley, New Britain. Cost $23.50 per ton in car lots delivered in Connecticut.

3728. Buffalo Gluten Feed. Bought of Stephen Hurd for $1.15 per 100 pounds. Sent by M. H. Wetmore, Winchester.

3736. Buffalo Gluten Feed. Made by American Glucose Co., Buffalo, N. Y. Sent by F. M. Bartholomew, East Wallingford. Cost $1.15 per 100 pounds.

3727. Chicago Gluten Meal. Bought of N. Bennett, West Winsted, for $1.25 per 100 pounds. Sent by M. H. Wetmore, Winchester. Messrs. C. M. Cox & Co., sales agents for Buffalo Gluten Feed claim that the three samples above noted do not fairly represent the quality of the article.

Wheat Feeds.

3717. Spring Bran, bought of James Lincoln, Berlin. Cost December, 1892, $16.25 per ton in car lots, delivered. Sent by T. A. Stanley, New Britain.

3719. Acme Bran, bought by Noble Bennett, New Britain. Cost $17.00 per ton in car lots, delivered. Sent by T. A. Stanley.

3720. Acme Bran, from Dakota. Bought of Levi Wells. Cost $17.00 per ton in car lots, delivered. Sent by T. A. Stanley.

3729. Middlings, bought of N. Bennett, West Winsted, for $1.15 per 100 pounds. Sent by M. Wetmore, Winchester.

3405. Fine White Wheat Middlings, used in feeding experiment at the Webb farm.

3737. Shorts, bought of Wilder & Puffer, Springfield, for $16.35 per ton in car lots, delivered. Sent by T. J. Stroud, Shaker Station.

3706. "Mixed Feed," made by Acme Milling Co. and sold by J. M. Williams, Manchester, at $21.00 per ton. Said to be the entire waste in the process of making fine flour. Sent by W. H. Olcott.

Oat Feed.

3124. Sent by B. F. Case, Canton Center. Cost $30.00 per ton in March, 1891.

3724. Sold J. M. Williams, Manchester, for $25.00 per ton in December, 1892. Sent by W. H. Olcott, South Manchester.

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Miscellaneous Feeds.

3421. Western Corn Meal, sent by N. S. Baldwin, Meriden.

3420. "Corn and Cob Meal," ground by N. S. Baldwin, from Eastern grown corn.

3117. Hominy Feed. Sent by F. H. Stadtmueller, Elmwood.

3510. Kiln-dried Starch Feed, costing $20.00, sent by E. A. Bradley, Centerville.

3147. Buffalo Kiln-dried Sugar Meal. Bought of American Glucose Co., Buffalo, N. Y., for use in feeding experiments.

3401. Malt Sprouts, bought of E. A. Talcott, Harwinton, for $20.00 per ton, January, 1892, by Henry Von Tobel, Harwinton.

3464. Buckwheat Flour. Sent by Theron F. Griswold, Little Haddam.

With the analyses are given for comparison the average composition of most of the feeds named as determined from a considerable number of analyses formerly made at American Experiment stations.

The comparison of the composition of "Western Corn Meal" with corn and cob meal made from sound Connecticut-grown corn shows the latter to be much drier, and to contain half a per cent. less albuminoids, but half a per cent. more fat, six per cent. more fiber, and one and eight tenths per cent. less of starchy matter.

There is nothing in the chemical analysis to indicate a decided difference in feeding value between the two.

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Analyses of Feeding Stuffs.

			Analysis.						Analysis, Calculated Water-Free.				
			Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.
Cotton Seed Meal,	from Middletown.	3110	8.23	7.62	44.50	4.38	25.77	9.50	8.3	48.5	4.8	28.1	10.3
	T. J. Stroud.	3148	9.43	7.52	41.12	6.07	29.93	5.93	8.3	45.4	6.7	33.1	6.5
	H. S. Lathrop.	3409	7.47	6.29	44.24	9.64	23.12	9.24	6.8	47.8	10.4	25.0	10.0
	T. A. Shaw.	3726	-----	-----	40.06	-----	-----	-----	-----	-----	-----	-----	-----
Average Composition,		----	**8.20**	**7.20**	**42.30**	**5.60**	**23.60**	**13.10**	**7.8**	**46.1**	**6.1**	**75.8**	**14.2**
Cotton Seed Feed,	half hulls and half meal,	3408	8.86	2.87	17.81	24.52	42.99	2.95	3.2	19.4	26.9	47.2	3.3
Linseed Meal,	T. A. Stanley.	3359	11.34	5.53	36.72	-----	-----	3.43	6.2	41.4	-----	-----	3.9
	T. A. Stanley.	3718	9.33	5.53	36.75	8.25	34.91	5.23	6.1	40.5	9.1	38.6	5.7
	E. C. Birge.	3142	10.92	5.54	35.69	7.50	33.05	7.30	6.1	40.1	8.4	37.2	8.2
	E. C. Birge.	3143	10.40	5.68	35.43	7.75	34.26	6.48	6.4	39.6	8.7	38.2	7.1
	W. H. Olcott.	3725	-----	-----	31.25	-----	-----	-----	-----	-----	-----	-----	-----
Old Process, Average Composition.		----	**9.20**	**5.70**	**32.90**	**8.90**	**35.40**	**7.90**	**6.3**	**36.2**	**9.7**	**39.2**	**8.6**
New Process, Average Composition,		----	**10.10**	**5.80**	**33.20**	**9.50**	**38.40**	**3.00**	**6.5**	**36.9**	**10.5**	**42.8**	**3.3**
Cream Gluten,	T. J. Stroud.	3363	8.98	.75	38.19	1.34	34.99	15.75	.9	42.0	1.4	38.4	17.3
Gluten Meal,	W. H. Olcott.	3536	-----	-----	24.06	-----	-----	-----	-----	-----	-----	-----	-----
Buffalo Gluten Meal,	T. A. Stanley.	3716	8.93	.70	24.06	5.79	48.82	11.70	.8	26.5	6.4	53.5	12.8
	M. H. Wetmore.	3728	7.85	.79	21.65	7.62	51.84	10.25	.9	23.5	8.2	56.2	11.2
	F. M. Bartholomew.	3736	7.79	.78	23.56	7.85	48.88	11.14	.9	25.6	8.5	53.0	12.0
Chicago Gluten Meal,	M. H. Wetmore.	3727	7.15	1.07	25.90	5.24	48.98	11.66	1.2	27.9	5.6	52.7	12.6
Wheat Feed, Spring Bran	T. A. Stanley.	3717	9.56	5.68	16.19	9.93	53.04	5.60	6.3	18.0	11.0	58.5	6.2
Acme Bran,	T. A. Stanley.	3719	9.86	5.90	17.75	7.15	54.39	4.95	6.5	19.8	8.0	60.2	5.5
Acme Bran,	T. A. Stanley.	3720	9.68	5.66	19.56	7.10	52.30	5.70	6.3	21.6	7.9	57.9	6.3
Bran, Average Composition.		----	**11.90**	**5.80**	**15.40**	**9.00**	**53.90**	**4.00**	**6.6**	**17.4**	**10.2**	**61.3**	**4.5**
Middlings,	M. H. Wetmore.	3729	9.44	4.40	18.57	6.22	56.12	5.25	4.9	20.5	6.9	61.9	5.8
Fine Middlings,	Station.	3405	9.54	-----	19.25	3.44	-----	4.23	-----	21.3	3.8	-----	4.7
Middlings, Average Composition,		----	**12.10**	**3.30**	**15.60**	**4.60**	**60.40**	**4.00**	**3.8**	**17.8**	**5.2**	**68.7**	**4.5**
Shorts,	T. J. Stroud.	3737	10.77	6.06	16.94	9.44	51.50	5.29	6.8	19.0	10.6	57.7	5.9
Mixed Feed,	W. H. Olcott.	3706	12.55	5.27	17.25	7.10	53.15	4.68	5.9	19.8	8.1	60.8	5.4

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Analyses of Feeding Stuffs—(Continued.)

			Analysis.						Analysis. Calculated Water-Free.				
			Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.
Oat Feed,	B. F. Case.	3134	8.23	4.13	17.87	7.60	55.37	6.80	4.5	19.5	8.3	60.3	7.4
	W. H. Olcott.	3724	6.68	3.94	16.86	8.18	56.66	7.68	4.2	18.0	8.8	60.7	8.3
Average Composition,			**7.70**	**3.70**	**16.00**	**6.10**	**59.40**	**7.10**	**4.0**	**17.3**	**6.6**	**64.4**	**7.7**
Western Corn Meal,	N. S. Baldwin.	3421	18.02	1.05	9.18	1.49	67.18	3.08	1.2	11.2	1.8	82.0	3.8
Average Composition,*			**15.00**	**1.40**	**9.20**	**1.90**	**68.70**	**3.80**	**1.6**	**10.8**	**2.2**	**81.0**	**4.4**
Corn and Cob Meal,	N. S. Baldwin.	3420	13.65	1.45	8.56	7.42	65.34	3.58	1.7	9.9	8 6	75.7	4.1
Average Composition,			**15.10**	**1.50**	**8.50**	**6.60**	**64.80**	**3.50**	**1.7**	**10.0**	**7.8**	**76.4**	**4.1**
Hominy Feed,	F. H. Stadtmueller.	3117	12.95	2.54	10.81	3.70	61.90	8.10	2.9	12.4	4 3	71.1	9.3
Average Composition,			**11.10**	**2.50**	**9.80**	**3.80**	**64.50**	**8.30**	**2.8**	**11.0**	**4.3**	**72.6**	**9.3**
Kiln-dried Starch Feed,	E. A. Bradley.	3510	9.24	.63	17.06	5.65	59.04	8.38	.7	18.8	6.2	65 1	9.2
Buffalo Kiln-dried Sugar Meal,	Station.	3147	11.45	1.22	21.82	5.17	49.21	11.13	1.4	24.6	5.8	55.6	12.6
Malt Sprouts	H. Von Tobel.	3401	12.91	6.19	23.13	11.58	44.81	1.38	7.1	26.6	13.3	51.5	1.5
Average Composition,			**10.20**	**5.70**	**23.20**	**10.70**	**48.50**	**1.70**	**6.3**	**25.8**	**11.8**	**54.2**	**1.9**
Buckwheat Flour,	T. F. Griswold.	3464	15.18	.92	5.63	.50	76.94	.83	1.1	6.6	.6	90.7	1.0
Average Composition,			**14.60**	**1.00**	**6.90**	**.30**	**75.80**	**1.40**	**1.2**	**8.0**	**.4**	**88.8**	**1.6**

* 77 analyses of corn meal from all localities.

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EXAMINATION OF THE SEED OF ORCHARD GRASS, *Dactylis glomerata.*

This species is one of the best meadow grasses. It roots deeply and is less affected by drought than most other grasses, it grows better in the shade than timothy or red-top and is earlier in bloom, it is believed to be more permanent than timothy on land suited to it and gives large crops. If cut before full bloom the hay is nutritious and not coarser or more strawy than timothy.

But little orchard grass is grown in this State. Many who have tried it have either failed to get a good catch or have got a catch altogether too good of grasses other than orchard grass, notably of meadow fescue, *Festuca pratensis*, perennial rye grass, *Lolium perenne*,—perennial only in name—and chess or cheat, *Bromus secalinus*. This fescue is a good meadow grass, but rye-grass and chess are very inferior or worthless.

The failures made in sowing orchard grass and the consequent indifference to it are largely to be explained by the quality of seed which is offered in market. To learn the state of the trade, this Station has examined six samples of seed bought by farmers of seedsmen in this State and six samples purchased in Boston and five in New York. The results of the botanical analyses and germination tests are given in the following table. The per cents of different seeds found in the samples are by *weight* and not by number. No attempt was made to identify other seeds than those named in the table. Many seeds were immature and the duplicate sprouting tests did not in some cases agree closely, but that the conditions of the tests were suitable is shown by the fact that good mature seed sprouted freely in the testing apparatus. Four tests were made of each of the samples from A to G and two tests of each of the others. The highest result in each case is given in the table. The last column of the table is prepared by multiplying the per cent. of pure orchard grass seed by the per cent. of this pure seed that is capable of sprouting and dividing the product by 100.

The result of this examination may be summarized as follows:

1. Of the 17 samples of Orchard grass seed purchased in New York, Boston, and at various places in Connecticut, one sample contained as much as 98.8 per cent. of pure seed the remainder being chaff.

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Another contained no orchard grass seed whatever, and consisted mainly of Lolium perenne, or perennial rye-grass.

Excluding this sample the other 16 samples contained on the average 77.4 per cent. of pure seed.

2. Seven out of sixteen samples contained notable quantities, from 8.3 to 35.5 per cent., of seed of perennial rye-grass, Lolium perenne, which is less valuable and sells at a lower price. "Tested" Orchard grass seed is quoted at 11 cents per pound and "tested" perennial rye grass at 4½ cents. A single sample contained 14.1 per cent. of a species of Bromus, probably secalinus or chess.

3. In one sample as high as 88 per cent. of the orchard grass seed sprouted, in another as low as 4.5 per cent. and on the average of 16 samples 50.0 per cent.

4. Taking the 16 samples together, the average quantity of pure orchard grass seed which was capable of sprouting was 40 per cent.; i. e. out of every 100 pounds bought, 40 pounds was pure, live seed. Probably the quantity that would produce healthy plants was less than this.

Examination of Orchard Grass Seed from the Connecticut, Boston, and New York Markets.

Mark.	Botanical Analysis.					Sprouting Test.		
	Orchard Grass.	Meadow Fescue.	Perennial Rye.	Bromus.	Other Seed, Chaff and dirt.	1000 seeds weigh grams.	Per cent. sprouting.	Per cent. of pure seed in sample capable of sprouting.
A	58.6	....	20.5	....	20.9	.666	41.0	**24.0**
B	69.6	....	....	14.1	16.3	.571	27.5	**19.1**
C	76.1	2 5	8.3	....	13.1	.773	43.0	**32.7**
D	67.2	4.7	8.9	....	19.2	.537	32.5	**21.8**
F	94.7	....	....	....	5.3	.621	40.5	**38.4**
G	43.9	....	23.1	....	33.0	.535	36.0	**15.8**
I	92.9	....	.. .	....	7.1	.729	54.5	**50.6**
J	87.8	....	....	....	12.2	.495	42.5	**37.3**
K	60.3	....	....	....	29.7	.588	44.0	**26.5**
L	88.2	....	....	....	11.8	.838	79.0	**69.7**
M	none.	....	....	....	....	....	....	**none.**
N	65.7	....	31.4	....	2.9	.609	4.5	**3.0**
O	98.8	....	....	....	1.2	.902	35.0	**34.6**
P	92.0	....	....	....	8.0	.555	88.0	**81.0**
Q	97.7	....	....	....	2.3	.740	76.5	**74.7**
R	81.6	....	15.7	....	2.7	.745	77.0	**62.8**
S	62.7	....	35.5	....	1.8	.779	82.5	**51.7**

It is very likely that rye grass is sometimes added as a "make-weight," and it may easily escape detection in a casual examination, but it often grows with orchard grass, and when the two

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kinds of seed are harvested together it is impossible by mechanical means to separate them.

Moreover, the trade seed of orchard grass even when pure is known to have a low germinating power both abroad and in this country, so that 30 to 35 pounds per acre of it make only moderate seeding.

The table of analyses shows however that it is still possible, if one will take pains enough and pay enough, to get quite clean seed of this grass of which over 60 per cent. will germinate.

A part of the trouble with the seed market is that while the best seed is naturally the most expensive, cheap seed is always the most popular.

The sample P represents seed for which there is absolutely no market in its pure state; it is too good for the trade and is mixed again for sale with inferior and less "expensive" seed.

It is obvious however that as compared with sample A, sample P is by far the more economical. In the first place a pound of P will produce more than three times as many plants of orchard grass as A. Again A will seed the land with some rye grass which is quite inferior to orchard grass. And lastly the catch of grass from the A seed will probably be poor, and very likely so poor that the land will have to be re-seeded. In this case it may lie idle for six months or a year and confirm the owner in the idea that orchard grass is not worth a trial.

To any one in the State desiring them, a few seeds each of Orchard grass, Perennial rye grass and Meadow Fescue will be sent by the Station to aid in their identification.

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ASH ANALYSIS OF WHITE GLOBE ONIONS.

From several barrels of White Globe Onions grown at Green's Farms were selected twenty-two bulbs of fair size which weighed five pounds and one ounce.

After drying and pulverizing them, a weighed sample of the powdered material was burned with the usual precautions and the ash submitted to analysis with the following results:

Per cent. Composition of the Pure Ash.

[Station No. 3005.]

Potash	43.49
Soda	1.26
Lime	10.87
Magnesia	4.46
Oxide of iron	1.07
Phosphoric Acid	19.08
Sulphuric Acid	15.98
Chlorine	2.36
Sand and Silica	1.96
	100.53
Deduct oxygen equivalent to chlorine	.53
	100.00

The fresh onions contain .27 per cent. of nitrogen and .48 per cent. of pure ash.

From these data are calculated the quantities of these ingredients contained in one ton (2000 pounds), of onions as follows:

Nitrogen and Mineral Matter in One Ton of Onions (Bulbs).

Nitrogen	2.70	pounds.
Phosphoric Acid	.92	"
Potash	2.09	"
Soda	.06	"
Lime	.52	"
Magnesia	.21	"
Oxide of Iron	.05	"
Sulphuric Acid	.77	"
Chlorine	.11	"
Sand and Silica	.09	"

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ANALYSES OF SOME AMERICAN CHEESES.

During the last few years a marked advance has been made in this country in the methods of cheese making, and there is scarcely one of the celebrated foreign cheeses that is not closely imitated in the United States. On page 157 are given analyses of eighteen samples of cheese, all of which, except the sample of Roquefort, are of American manufacture. The methods used for the analyses are essentially those described in the U. S. Dep't. Ag., Div. of Chem., Bull. 35, page 224. A description of the samples follow.

3754. Full cream cheese. Made by the Lebanon Cheese Co., Lebanon, Conn.

3755 and **3756.** Purchased in New Haven for 16 cents per pound. These represent fairly the kind of cheese most commonly sold in our market.

3757. Full cream cheese, old. Bought in New Haven.

3758–3761. Pineapple cheese from E. Norton, Goshen, Conn. The Goshen factory is the oldest in the United States, and the pineapple cheese has a wide reputation.

3762 and **3763.** Skim milk cheese. Bought in New Haven, 12 cents per pound.

3764. Neufchatel. Small cheeses wrapped in tin foil. Sell for 5 cents apiece.

3765. Fromage de Brie. Said to be made in Orange Co., N. Y.

3766. Imitation Old English cheese. 20 cents per pound. Bought in New Haven.

3767. Swiss ["Schweitzer"]. 20 cents per pound. Bought in New Haven.

3768. Cream cheese. Crown Brand. 25 cents apiece. Bought in New Haven.

3769. Limburger. Bought in New Haven.

3770. A cheese resembling pineapple in texture, made by J. Hohlridge, West Burlington, N. Y. Sample received from Hon. T. S. Gold, West Cornwall.

3771. Roquefort. Imported. 50 cents per pound. Bought in New Haven.

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ANALYSES OF CHEESE.

Station No.		Water.	Ash, excluding Salt.	Salt.	Protein (N X 6.4).	Fat.	Organic Acids and other matters by difference.	Volatile Fatty Acids in 2.5 grams Fat.*
3754	Full cream (Lebanon)	34.88	2.64	1.32	23.06	35.10	3.00	....
3755	" "	36.75	3.64		23.19	35.12	1.30	14.0
3756	" "	35.67	2.63	1.19	24.00	34.74	1.77	15.1
3757	Full cream, old	29.87	2.80	.99	28.31	35.62	2.41	....
3758	Pineapple, yellow, 4 months old	30.95	3.29	2.34	27.00	33.26	2.16	13.4
3759	" white, 8 "	28.01	2.96	2.14	27.12	37.25	2.52	14.6
3760	" yellow, 16 "	25.69	3.57	2.61	28.81	36.76	2.56	12.6
3761	" " 5 years old	11.62	4.02	1.86	34.45	45.20	2.75	13.8
3762	Skim milk	52.15	2.45	1.70	26.31	15.35	2.04	16.5
3763	"	53.08	3.09	1.22	26.81	13.80	2.00	14.7
3764	Neufchatel	57.25	1.06	1.42	15.03	22.30	2.94	13.4
3765	Fromage de Brie	60.20	1.13	.40	15.94	20.96	1.37	16.2
3766	Imitation Old English	20.74	3.68	1.47	30.12	42.72	1.27	15.8
3767	Swiss	33.79	3.22	1.85	26.12	33.25	1.77	....
3768	Cream, Crown Brand	31.40	.45	2.72	5.25	57.98	2.20	....
3769	Limburger	42.12	1.59	3.51	23.00	29.40	.38	14.6
3770	Cheese made by J. Hohlridge	18.66	3.76	1.38	32.16	41.80	2.24	....
3771	Roquefort	39.28	1.53	5.27	22.62	29.53	1.77	9.1

* Volatile fatty acids were determined by Reichert's method in 2.5 grams of the ether extract. The figures represent cubic centimeters of $\frac{1}{10}$ normal potash solution required to neutralize the volatile acids. The small quantity of volatile fatty acids found in Roquefort is probably to be explained by the decomposition of fats during the peculiar ripening process.

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STATE OF CONNECTICUT

SEVENTEENTH ANNUAL REPORT

— OF —

The Connecticut Agricultural Experiment Station.

For 1893.

Printed by Order of the General Assembly.

The publications of this Station are sent free to every citizen of Connecticut who applies for them. Address, The Conn. Agricultural Experiment Station, New Haven, Conn.

NEW HAVEN:
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The Exp. Station.

CORRECTIONS.

Page 11. From third line of middle paragraph on *Free Nitrogen*, expunge the words "and mustard."

Page 26, third line of table; change "Reed Co., Brooklyn, N. Y." to "Read Co., New York City."

Page 38, after No. **3907**, insert "Clark's Cove Bay State Fertilizer G.G." Change the guaranteed nitrogen of this brand from 2.3 to *1.85* per cent.

Page 38. No. **3952**. Change the guaranteed nitrogen of Quinnipiac Ammoniated Dissolved Bone from 2.0 to *1.65* per cent.

Page 39. No. **3978**. Change the guaranteed nitrogen of Quinnipiac Pine Island Phosphate from 2.5 to *2.06* per cent.

Page 50. No. **3909**. For Bradley's read Bowker's.

Page 147, third line of the title, for "*Seperator*," read *Separator*.

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OFFICERS AND STAFF FOR 1893.

STATE BOARD OF CONTROL.

Ex-officio.

HIS EXCELLENCY LUZON B. MORRIS, *President.*

	Term expires.
Appointed by Connecticut State Agricultural Society:	
HON. E. H. HYDE, Stafford, *Vice-President.*	July 1, 1894.
Appointed by Board of Trustees of Wesleyan University:	
PROF. W. O. ATWATER, Middletown.	1894.
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1895.
JAMES H. WEBB, Hamden.	1896.
Appointed by Board of Agriculture:	
T. S. GOLD, West Cornwall.	1895.
Appointed by Governing Board of Sheffield Scientific School:	
W. H. BREWER, New Haven, *Secretary and Treas.*	1896.
Ex-officio.	
S. W. JOHNSON, New Haven, *Director.*	

Executive Committee.

STATION STAFF.

Chemists.

S. W. JOHNSON, *Director.*
E. H. JENKINS, PH.D., *Vice-Dir.*
A. L. WINTON, PH.B.
T. B. OSBORNE, PH.D.
A. W. OGDEN, PH.B.
H. MONMOUTH SMITH, B.A.*
W. R. JOHNSTON, PH.B.†
R. S. CURTISS, PH.D.‡

Mycologist.

WILLIAM C. STURGIS, PH.D.

Grass Gardener.

JAMES B. OLCOTT, South Manchester.

Stenographer and Clerk.

MISS F. M. BIGELOW.* MISS C. S. GREEN.†

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helpers.

HUGO LANGE. JULIUS KORN.

Sampling Agents.

DENNIS FENN, Milford. F. R. CURTISS, Stratford.

*Till Aug. 1. †From Oct. 1. ‡From July to December.

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Notice as to Bulletins.

The Bulletins of this Station, usually issued quarterly or oftener, are mailed free to citizens of Connecticut who apply for them, and to others, as far as the limited editions permit.

Applications should be renewed annually before January 1st.

The matter of all the Bulletins of this Station, in so far as it is new or of permanent value, will be made part of the Annual Report of the Director.

Bulletins earlier than No. 71 and Nos. 83, 92, 93, 100, 101, and 109 are exhausted and cannot be supplied.

Notice as to Supply of Station Reports.

The Station has no supply of its Annual Reports for the years 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1884, 1887, and 1891.

The Annual Report of this Station, printed at State expense, is by law limited to an edition of 12,000 copies, of which 5,000 copies are bound with the Annual Report of the Connecticut State Board of Agriculture, and distributed by the Secretary of the Board, T. S. Gold, West Cornwall, Conn.

After exchanging with other Experiment Stations and Agricultural Journals, the Reports remaining at the disposal of the Station will be sent to citizens of Connecticut who shall seasonably apply for them, and to others as long as the supply lasts.

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ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, moulds, blights, mildews, useful or injurious insects, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station does not undertake sanitary analyses of water.

The Station makes analyses of Fertilizers, Seed-Tests, etc., etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.

2. That the samples are taken from stock now in the market, and in accordance with the Station "Instructions for Sampling."

3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs, and like Associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the private use of individuals is charged for at moderate rates. The Station undertakes no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of immediate general interest are published in Bulletins, copies of which are sent to each Post Office in this State, and to every citizen of the State who applies for them. The results of all the work of the Station are summed up in the Annual Reports made to the Governor.

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It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention should be *prepaid*.

☞ Letters sent to individual officers are liable to remain unanswered in case the officer addressed is absent. All communications therefore should be directed simply to the

AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

☞ Station Grounds, Laboratories and Office are on Suburban st., between Whitney avenue and Prospect st., 1¼ miles north of City Hall. Suburban st. may be reached by Whitney ave. Electric Cars, which leave the corner of Chapel and Church sts., three times hourly, viz: on the striking of the clock and at intervals of twenty minutes thereafter.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 118 Court st., or from Peck & Bishop's Office in Union R. R. Depot.

☞ The Grass Garden, in charge of Mr. James B. Olcott, is near South Manchester and may be reached by A. Gardner's regular Passenger Express starting at 9 A. M. and 1 P. M. from Cheney's Store, So. Manchester, or starting at 10 A. M. and 4 P. M. from Burnside, where connection is made by electric car with Hartford.

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REPORT OF THE TREASURER.

WM. H. BREWER, IN ACCOUNT WITH THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, FOR THE FISCAL YEAR ENDING SEPTEMBER 30TH, 1893.

RECEIPTS.

From the State Comptroller	$8,000.00	
" U. S. Treasurer	7,500.00	
Analysis Fees due last fiscal year and received this year	1,633.92	
Analysis Fees of this year	4,496.11	
Miscellaneous Receipts	40.77	
		$21,670.80

PAYMENTS.

	State Acc't.	U. S. Acc't.	Total.
Salaries	$5,755.00	$6,709.63	$12,464.63
General Laboratory Expenses	2,042.39	27.59	2,069.98
Mycological Expenses	.....	85.66	85.66
Grass Investigation	871.00	150.00	1,021.00
Tobacco Investigation	353.32	198.26	551.58
Field Experiments	.....	194.62	194.62
The Establishment, Repairs, Grounds, etc.	1,464.26	.....	1,464.26
Gas	266.70	.....	266.70
Water	147.00	.....	147.00
Coal	593.25	.....	593.25
Telephone	100.25	.....	100.25
Printing	669.07	134.24	803.31
Stationery	98.53	.....	98.53
Comptometer	125.00	.....	125.00
Postage	144.33	.....	144.33
Library	365.33	.....	365.33
Collecting Fertilizers	361.51	.....	361.51
Traveling Expenses of the Board	64.57	.....	64.57
Columbian Exposition	403.23	.....	403.23
Unclassified Sundries	346.06	.....	346.06
	$14,170.80	$7,500.00	$21,670.80

MEMORANDUM.

The above accounts were duly audited December 27th, 1893, by the State Auditors of Public Accounts.

As in previous years, the Analysis Fees of fertilizers known to be on sale after May 1st and subject to the law concerning commercial fertilizers, coming into the hands of the treasurer after the closing of this account will be credited to the next year's account.

WM. H. BREWER, *Treasurer.*

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REPORT OF THE BOARD OF CONTROL.

To his Excellency, Luzon B. Morris, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station, as required by statute, herewith submits to your Excellency its report for the year ending November 1st, 1893.

In execution of the provisions of the Fertilizer Law, the agents of this Station have visited all parts of Connecticut, and have drawn samples of commercial fertilizers, representing nearly all brands sold within the State.

Two hundred and eighty-four analyses of fertilizers and manurial waste products have been made in the laboratory, and the results of these analyses are now in the printer's hands for publication.

Within the last eighteen months the extremely high prices of organic nitrogenous matters have largely increased the temptation to use in mixed fertilizers very inferior materials, such as ground leather, horn and wool. Every fertilizer analyzed, has therefore been tested for leather and also as to its solubility in pepsin solution.

A parallel series of tests, though not so extensive, has been made to compare the rapidity with which the nitrogenous matters of different fertilizers become soluble in water by putrefactive decomposition.

In connection with the same subject 24 experiments have been made, in which Indian corn was grown in an artificial soil in pots supplied with nitrogen from six different fertilizers whose relative value as regards their nitrogen it was thus sought to determine.

Ninety samples of maize kernel, all of which are represented in the Station's collection of varieties, have been analyzed and of these analyses forty-two have been used in the Connecticut corn exhibit at the Columbian Exposition. A considerable number of feeding stuffs have also been analyzed for individual purchasers.

In connection with Farmers' Institutes where dairying was discussed and also in response to requests at other times by creameries and private individuals, 93 samples of milk and 35 samples

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of cream have been examined. Seven samples of skimmed milk, 14 of cream, 8 of butter and 15 of butter-milk have been completely analyzed as part of the dairy experiment to be noticed later.

A large amount of work has been done in the study of Methods of Milk-Analysis, chiefly for comparing the per cent. of milk-solids determined by gravimetric methods with the per cent. of solids calculated from the per cent. of fat and the specific gravity; and for comparing different gravimetric methods of determining milk-solids.

All the chemical work required by the State Dairy Commissioner has been furnished, including the examination of 57 samples of suspected butter and expert evidence has been given in court, as required.

The work done by Dr. T. B. Osborne and his assistants since November 1st, 1892, is briefly summarized as follows:

During the year the investigation of the proteids of the wheat kernel has been completed and the results published in the American Chemical Journal, Vol. XV, No. 6, occupying 80 octavo pages.

The proteids of the rye kernel and of the kidney bean have also been investigated and the results are nearly ready for publication.

The study of the proteids of the cotton seed, begun some time ago has been finished, and the results are now ready for the printer. The proteids of the barley kernel have also been examined, but this investigation is not yet complete.

The subjects that have occupied the attention of Dr. W. C. Sturgis, the Station botanist, are as follows:

A study of the comparative value of winter and summer treatments in preventing the "scab" of apples and pears.

The continuation of the experiments of last year upon the artificial curing of tobacco.

Experimental work on the prevention of the mildew of lima beans.

Further prosecution of the experiments of last year on the prevention of potato "rot."

A study of a disease of asters and other plants of the same order caused by nematode worms; and the use of lime incorporated with the soil, as a remedy.

The use of sulphur against the "leaf-blight" of celery and mildew of grapes under glass.

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Investigation of diseases of quinces, including laboratory experiments upon the germination of the spores of the "rot" fungus and a critical study of a disease of quinces new to this locality.

Under the direction of Mr. James B. Olcott the study of grasses has been continued during the past year at South Manchester.

In connection with the State Dairymen's Association and the Woodstock creamery a series of observations has been made: First, to study the loss of fat in the butter milk, when gravity-cream and separator-cream are ripened and churned together, compared with the loss when each is churned by itself. Second, to compare the efficiency of the two systems of separating butter-fat, using milk of the same herd, under the most favorable conditions.

The field experiment, on the growth of maize, noticed in previous reports, has been continued this year on the farm of James H. Webb, Esq., of Hamden.

In coöperation with S. D. Woodruff & Sons of Orange, a field experiment has been carried out to test the effect of nitrate of soda in forcing the tomato crop.

The experiments on the effect of different fertilizers on quality and quantity of the tobacco crop, of which the first report was made last year, have been enlarged in scope and carried on this year, as before, in connection with the Connecticut Tobacco Experiment Co. at Poquonock. The last General Assembly appropriated the sum of five hundred dollars ($500.00) to be spent by the Station in this work.

Three Bulletins have been issued during the year, Nos. 114, 115 and 116, covering 58 octavo pages.

The subject of No. 115 was, Common Fungous Diseases and their Treatment, Nos. 114 and 116 were regarding Fertilizers. The demand for Bulletin 115, issued in March, 1893, was so great, that a new and revised edition was printed in May. The matter of Bulletin 114 appeared in our Annual Report for 1892; that of Bulletins 115 and 116 is incorporated with the Annual Report for the present year. Bulletin 112, issued last year but not printed in the Report for 1892, is included in the Annual Report for this year. Bulletin 111, issued in March, 1892, was not printed in the Annual Report for that year, but after revision appeared as Bulletin 115 and is accordingly a part of the Annual Report for 1893.

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During the present year the Station has been called upon more frequently than ever before for assistance at Farmers' Institutes, Grange meetings, gatherings of Dairymen, etc. On 29 days, one, two and sometimes three of the Station staff, were engaged in this work.

There have been two changes in the Station staff during the year. H. Monmouth Smith, B.A., chemist to the Station, was succeeded on October 1st, by William R. Johnston, Ph.B.

Dr. R. S. Curtiss, who was on the Station staff as chemist during the years 1888, 1889 and a part of 1890, and who has since that time been abroad for further chemical study, is now engaged in a special study of soils at this Station.

A detailed account of all the work above referred to, will be found in the Report of the Director, which is now in preparation.

All of which is respectfully submitted.

WM. H. BREWER,
Secretary.

NEW HAVEN, CONN., November 1st, 1893.

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REPORT OF THE DIRECTOR.

A general summary of the work done at this Station during the year ending Nov. 1st, may be found in the report of the Board of Control to the Governor.

The detailed account of this work, so far as it is sufficiently advanced to justify its publication, is contained in the following pages.

In the discussion of commercial fertilizers it is found necessary to repeat annually certain statements regarding the fertilizer law and the analysis and valuation of fertilizers, to answer the questions which are constantly addressed to the Station on these subjects.

THE CONNECTICUT FERTILIZER LAW.

The General Assembly at its Session in 1893 passed an act, Chapter CLXXII, amending the fertilizer law previously in force in Connecticut.

The attention of all concerned is called to the following copy of the General Statutes of the State regarding fertilizers which embodies the amendments and is the law now in force.

Copies of the law may be had on application to the Station. Attention is specially called to the following requirements.

1. In case of *all* fertilizers or manures, except stable manure and the products of local manufacturers of less value than ten dollars a ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER shall have provided labels or statements and shall have paid the fee. Sections 4005 and 4007.

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The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, and which are generally Nitrogen, Phosphoric acid and Potash. The analysis-fees in case of any fertilizer will therefore usually be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, *in the case of every commercial fertilizer*, that a *sealed sample* shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him, Section 4006.

A statement of the per cent. of Nitrogen, Phosphoric acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients: Nitrogen, Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide): that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price*, shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4008.

4. All "CHEMICALS" that are applied to land, such as: Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Lime (Gypsum or Land Plaster), Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 4013 of the Act.

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It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 4013, that all fertilizers be analyzed and it requires the parties making or selling them to pay for these analyses in part: the State itself paying in part by maintaining the Experiment Station.

ACTS CONCERNING COMMERCIAL FERTILIZERS.

Chapter CCLIII of the General Statutes of Connecticut as amended by Chapter CLXXII of the Acts of the General Assembly, Session of 1893.

Printed Statement to be affixed to all packages and to go with all lots.

SECTION 4005. Every person or company who shall sell, offer, or expose for sale, in this State, any commercial fertilizer or manure except stable manure and the products of local manufacturers of less value than ten dollars a ton, shall affix conspicuously to every package thereof a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trade-mark under which the fertilizer is sold, the name and address of the manufacturer, the place of manufacture and the chemical composition of the fertilizer, expressed in the terms and manner approved and usually employed by the Connecticut Agricultural Experiment Station.

If any such fertilizer be sold in bulk, such printed statement shall accompany every lot and parcel sold, offered, or exposed for sale.

Before sale certified copies of statement and sealed sample to be deposited with director.

SEC. 4006. Before any commercial fertilizer is sold, offered, or exposed for sale, the manufacturer, importer, or person who causes it to be sold, or offered for sale, within this state shall file with the director of the Connecticut Agricultural Experiment Station two certified copies of the statement prescribed in section 4005, and shall deposit with said director a sealed glass jar or bottle containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

Analysis fee to be paid annually on or before May 1.

SEC. 4007. The manufacturer, importer, agent, or seller of any commercial fertilizer shall pay on or before May 1, annually, to the director of the Connecticut Agricultural Experiment Station, an analysis fee of ten dollars for each of the fertilizing ingredients

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contained or claimed to exist in said fertilizer: *provided*, that when the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee prescribed in this section.

Yearly report to Station of dealers or agents

SEC. 4008. Every person in this State who sells, or acts as local agent for the sale of any commercial fertilizer of whatever kind or price, shall annually, or at the time of becoming such seller or agent, report to the director of the Connecticut Agricultural Experiment Station his name, residence, and post-office address, and the name and brand of said fertilizer, with the name and address of the manufacturer, importer, or party from whom such fertilizer was obtained, and shall, on demand of the director of the Connecticut Agricultural Experiment Station, deliver to said director a sample suitable for analysis of any such fertilizer or manure then and there sold or offered for sale by said seller or agent.

Leather.

SEC. 4009. No person or party shall sell, offer, or expose for sale, in this state any pulverized leather, raw, steamed, roasted, or in any form, as a fertilizer or as an ingredient of any fertilizer or manure, without explicit printed certificate of the fact, such certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany every parcel or lot of the same.

Fish guano, etc.

SEC. 4010. Every manufacturer of fish guano, or fertilizers of which the principal ingredient is fish or fish-mass from which the oil has been extracted, shall, before manufacturing or heating the same, and within thirty-six hours from the time such fish or mass has been delivered to him, treat the same with sulphuric acid or other chemical, approved by the director of said experiment station, in such quantity as to arrest decomposition: *provided, however*, that in lieu of such treatment such manufacturers may provide a means for consuming all smoke and vapors arising from such fertilizers during the process of manufacture.

Penalties.

SEC. 4011. Any person violating any provision of the foregoing sections of this chapter shall be fined one hundred dollars for the first offense, and two hundred dollars for each subsequent violation.

Fertilizers for private use.

SEC. 4012. This chapter shall not affect parties manufacturing, importing, or purchasing fertilizers for their own private use, and not to sell in this State.

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Director's duties and authority.

SEC. 4013. The director of the Connecticut Agricultural Experiment Station shall pay the analysis-fees received by him into the treasury of the station, and shall cause one or more analyses of each fertilizer to be made and published annually. Said director is hereby authorized, in person or by deputy, to take samples for analysis from any lot or package of manure or fertilizer which may be in the possession of any dealer.

Bulletins.

SEC. 4014. The director of the Connecticut Agricultural Experiment Station shall, from time to time, as bulletins of said station may be issued, mail or cause to be mailed two copies, at least, of such bulletins to each post-office in the State.

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OBSERVANCE OF THE FERTILIZER LAW.

MANUFACTURERS who have paid Analysis Fees as required by the Fertilizer Law, and Fertilizers for which the Fees have been thus paid for the year ending May, 1893.

Firm.	*Brand of Fertilizer.*
Baker, H. J. & Co., 93 William St., New York.	Standard UnXLD Fertilizer. A. A. Ammoniated Superphosphate. Special Potato Manure. " Corn Manure. " Tobacco Manure. " Onion Manure. Harvest Home Phosphate. Castor Pomace. Pure Ground Bone.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Special Tobacco Manure. " " Grain Manure. " " Grass Top-Dressing and Forage Crop Manure. Stockbridge Special Potato and Vegetable Manure. Bowker's Hill and Drill Phosphate. " Farm and Garden Phosphate or Ammoniated Bone Fertilizer. " Potato Manure. " Tobacco Grower. " Sure Crop Bone Phosphate.
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Bradley's Superphosphate. " Potato Manure. " Complete Manure for Potatoes and Vegetables. " Complete Manure for Top-Dressing Grass and Grain. " Complete Manure for Corn and Grain. " Pure Fine Ground Bone. " Circle Brand Ground Bone and Potash. " Fish and Potash, Anchor Brand. " Fish and Potash, Triangle A Brand. " B. D. Sea Fowl Guano. " Original Coe's Superphosphate. " Farmer's New Method Fertilizer. " High Grade Tobacco Manure.
Chicopee Guano Co., 140 Maiden Lane. New York City.	Chicopee Potato Manure. " Farmer's Reliable.
Clark's Cove Fertilizer Co., Farlow Building, State St., Boston, Mass.	Bay State Fertilizer. Bay State Fertilizer, G. G. King Philip Alkaline Guano. Potato and Tobacco Fertilizer. Great Planet Manure.

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Firm.	*Brand of Fertilizer.*
Cleveland Linseed Oil Co., Euclid Av., Cleveland, O.	Connecticut Wrapper Fertilizer.
Coe Co., The E. Frank, 16 Burling Slip, New York City.	High Grade Potato Fertilizer. High Grade Phosphate. Ground Bone and Potash. New England Tobacco Fertilizer. Gold Brand Excelsior Fertilizer. Fish and Potash. Alkaline Bone.
Cooper's Glue Factory, Peter, 17 Burling Slip, New York City.	Bone Dust.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Crocker's Ammoniated Bone Superphosphate. " Potato, Hop and Tobacco Phosphate. " Special Potato Manure. " Ammoniated Wheat and Corn Phosphate. " New Rival Ammoniated Superphosphate. " Ammoniated Practical Superphosphate. " Vegetable Bone Superphosphate. " Special Conn. Tobacco Manure. " Pure Ground Bone. " Ground Bone Meal.
Cumberland Bone Phosphate Co., Portland, Maine.	Cumberland Superphosphate. Cumberland Potato Fertilizer.
Darling Fertilizer Co., The L. B., Pawtucket, R. I.	Darling's Animal Fertilizer. " Fine Ground Bone. " Extra Bone Phosphate. " Potato and Root Crop Manure. " Tobacco Grower.
Downes & Griffin, Birmingham, Conn.	Ground Bone.
Ellsworth, F., Hartford. Conn.	Shoemaker's Swift Sure Superphosphate. " " " Bone Meal. Collier Castor Pomace.
Great Eastern Fertilizer Co., Rutland, Vt.	Great Eastern General Fertilizer for Grass and Grain. Great Eastern General Phosphate for Oats, Buckwheat and Seeding Down. Great Eastern Vegetable, Vine and Tobacco Fertilizer.
Hull, H. C., Meriden, Conn.	Ground Bone.
Kelsey, E. R., Branford, Conn.	Bone, Fish and Potash.

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Firm.	*Brand of Fertilizer.*
Lister's Agricultural Chemical Works, Newark, N. J.	Celebrated Ground Bone. Ammoniated Dissolved Bone. Potato Fertilizer. Standard Superphosphate. Success Fertilizer.
Mapes Formula and Peruvian Guano Co., 143 Liberty St., New York City.	Complete Manure for Light Soils. " " " General Use. " " " "A" Brand. Potato Manure. Corn Manure. Tobacco Starter. Fruit and Vine Manure. Grass and Grain Spring Top Dressing. Tobacco Manure, Wrapper Brand. Seeding Down Manure. Fine Dissolved Bone.
Miles Fertilizer and Oil Co., Milford, Conn.	Geo. W. Miles Brand, Fish Guano.
Miller, Geo. W., Middlefield, Conn.	Pure Ground Bone. Flour of Bone Phosphate.
National Fertilizer Co., Bridgeport, Ct.	Chittenden's Complete Fertilizer. " Ammoniated Bone Phosphate. " Fish and Potash. " Ground Bone. Russell Coe's Phosphate.
Frederick Nuhn, Waterbury, Conn.	Self-Recommending Fertilizer.
Olds & Whipple, Hartford, Conn.	Red Seal Castor Pomace.
Peck Brothers, Northfield, Conn.	Pure Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Ground Bone.
Preston Fertilizer Co., Greenpoint, L. I.	Onion Fertilizer. Potato Fertilizer. Ammoniated Bone Superphosphate. Ground Bone.
Quinnipiac Co., 92 State St., Boston, Mass.	Phosphate. Potato Manure. Market Garden Manure. Bone Meal. Ammoniated Dissolved Bone. Fish and Potash, Crossed Fishes Brand. Fish and Potash, Plain Brand. Pine Island Phosphate. Havana Tobacco Fertilizer. Corn Manure. Dry Ground Fish. Sulphate of Potash. Muriate of Potash. Sulphate of Ammonia. Dissolved Bone Black.

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Firm.	*Brand of Fertilizer.*
Read Fertilizer Co., Box 3121, New York City.	Read's Standard. High Grade Farmer's Friend. Fish and Potash. Vegetable and Vine Fertilizer.
Reese, J. S. & Co., 10 South St., Baltimore, Md.	Reese's Potato Special. Reese's New England Favorite. Pilgrim Fertilizer.
Rogers & Hubbard Co., Middletown, Ct.	The Rogers & Hubbard Co's Pure Ground Raw Knuckle Bone Flour. Pure Ground Raw Knuckle Bone Meal Strictly Pure Fine Bone. Fertilizer for Oats and Top-Dressing. Soluble Potato Manure. Soluble Tobacco Manure. Grass and Grain Fertilizer. Fairchild's Formula for Corn and General Crops.
Rogers Mfg. Co., Rockfall, Conn.	Pure Ground Bone.
Sanderson, L., New Haven, Conn.	Old Reliable Superphosphate. Pulverized Bone Meal. Blood, Bone and Meat. Fine Ground Fish. Muriate of Potash. High Grade Sulphate of Potash. Regular Sulphate of Potash. Nitrate of Soda. Sulphate of Ammonia. Dissolved Bone Black. Formula A.
Soluble Pacific Guano Co., Box 1368, Boston, Mass.	Pacific Guano. Potato Manure. High Grade General.
Standard Fertilizer Co., Farlow Building, State St., Boston, Mass.	Potato and Tobacco Fertilizer. Complete Manure. Superphosphate.
Walker, Stratmann & Co., Pittsburgh, Pa.	Potato Special. Tobacco Special. Banner Fertilizer. Four Fold Fertilizer.
Wilcox, Leander, Mystic, Conn.	Potato, Onion and Tobacco Manure. Ammoniated Bone Phosphate No. 1. Ammoniated Bone Phosphate No. 2. High Grade Fish and Potash.
Wilkinson & Co., 54 William St, New York City.	Economical Bone Fertilizer.
Williams & Clark Fertilizer Co., 71 Fulton St, New York City.	Americus Ammoniated Bone Superphosphate. " Brand Potato Phosphate. " High Grade Special. " Brand Pure Bone Meal. " Brand Fine Wrapper Tobacco Grower. " Corn Phosphate. Royal Bone Phosphate.

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ANALYSES OF FERTILIZERS.

During the year 284 samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given on page 16.

On a few of these samples analyses were made for private parties and charged for accordingly. A few samples also were analyzed at request of other Experiment Stations in order to compare and test analytical methods. Results of the examination of all the samples, with these exceptions, are given in detail in the following pages.

During April, May and June, Messrs. Dennis Fenn of Milford, and F. R. Curtiss of Stratford, agents of this Station, visited ninety-eight towns and villages in Connecticut and drew 652 samples representing more than 160 distinct brands of commercial fertilizers.

In this way one or more samples were secured of nearly every brand of fertilizer which is offered for sale within the State. When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agents are instructed in every case to open at least three packages of each brand for sampling, and if the number of packages is large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

As a rule, the Station will not analyze samples—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs, and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. All samples drawn by other than Station agents *must* be drawn in accordance with the Station's Instructions for sampling, and properly certi-

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fied, if the Station analysis is desired. A copy of these instructions and blank certificates will be sent on application.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for explanation or protest, if desirable, before the results are published in the Bulletin.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

Explanations Concerning the Analysis of Fertilizers and the Valuation of their Active Ingredients.

Revised.

Nitrogen is the most rare, and commercially the most valuable element of fertilizers.

Free Nitrogen is universally abundant, making up nearly four-fifths of the common air, and is assimilable, with aid of certain bacteria, by leguminous plants (the clovers, alfalfa, peas, beans), and mustard, but whether it can nourish cereals or other crops is as yet doubtful.

Organic Nitrogen is the nitrogen of animal or vegetable matters, which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated.

Ammonia (NH_3) *and nitric acid* (N_2O_5) are results of the decay of *organic nitrogen* in the soil and manure heap, and contain Nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda. 17 parts of ammonia or 66 parts of pure sulphate of ammonia contain 14 parts of nitrogen. 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

Phosphorus is, next to nitrogen, the most costly ingredient of Fertilizers, in which it always exists in the form of phosphates, usually those of calcium, iron and aluminum, or in case of some "superphosphates," in the form of free phosphoric acid.

Soluble Phosphoric acid implies phosphoric acid or phosphates that are freely soluble in water. It is the characteristic ingredient of Superphosphates, in which it is produced, by acting on "insoluble" or "reverted" phosphates, with diluted sulphuric acid (oil of vitriol). Once well incorporated with the soil, it gradually becomes reverted phosphoric acid. It is often termed *water-soluble phosphoric acid.*

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Reverted (reduced or precipitated) Phosphoric acid means strictly, phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid. In present usage the term signifies the phosphoric acid (of various phosphates) that is freely taken up by a strong solution of ammonium citrate, which is therefore used in analysis to determine its quantity. It may also be designated *citrate-soluble phosphoric acid.* "Reverted phosphoric acid" implies phosphates that are readily assimilated by crops.

Recent investigation tends to show that soluble and reverted phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the soluble gives better results on crops, in others the reverted is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric acid implies various phosphates not soluble in water or ammonium citrate. In some cases the phosphoric acid is too insoluble to be readily available as plant food. This is especially true of the crystallized green Canada Apatite. Bone-black, bone-ash, South Carolina Rock and Navassa Phosphate when in coarse powder are commonly of little repute as fertilizers though good results are occasionally reported from their use. When *very finely pulverized* ("floats") they more often act well, especially in connection with abundance of decaying vegetable matters. The phosphate of calcium in raw bones is nearly insoluble, because of the animal matter of the bones, which envelopes it; but when the latter decays in the soil, the phosphate remains in essentially the "reverted" form. The phosphoric acid of "Thomas-Slag" and of "Grand Cayman's Phosphate" is in some soils as freely taken up by crops as the water-soluble phosphoric acid but in other soils is much less available.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid," (P_2O_5), also termed among chemists, phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of fertilizers, which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride).

The Valuation of a Fertilizer, as practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend chiefly for their trade-value on the three substances, *nitrogen*, *phosphoric acid* and *potash*, which

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are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above named ingredients*, a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

The average Trade-value or retail cost in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash, as found in New England, New York and New Jersey markets, are as follows:

The Trade-Values for 1893 of Fertilizing Ingredients in Raw Materials and Chemicals.

The average Trade-values or *retail cost per pound* of the ordinarily occurring forms of nitrogen, phosphoric acid and potash are as follows:

	Cts. per lb.
Nitrogen in ammonia salts	17
nitrates	15½
Organic nitrogen in dry and fine ground fish, meat and blood	17½
in cotton seed meal and castor pomace	16½
in fine bone and tankage	15
in fine-medium bone and tankage	12
in medium bone and tankage	9
in coarser bone and tankage	7
in hair, horn shavings and coarse fish scrap	7
Phosphoric acid, soluble in water	6½
in ammonium citrate*	6
in dry ground fine fish, bone and tankage	6
in fine-medium bone and tankage	5
in medium bone and tankage	4
in coarse bone and tankage	3
in fine ground fish, cotton seed meal, castor pomace and wood ashes	5
insoluble in ammonium citrate, in mixed fertilizers	2
Potash as high-grade sulphate and in forms free from muriate (or chlorides)	5½
as muriate	4½

* Dissolved from 2 grams of the unground phosphate previously extracted with pure water, by 100 c. c. neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

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These Trade-values were agreed upon by the Experiment Stations of Massachusetts, New Jersey, Rhode Island, and Connecticut, for use in their respective States during 1893. They are the average prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those raw materials which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as:

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried Blood,	Plain Superphosphates,
Azotin,	Dry Ground Fish,
Ammonite,	Bone and Tankage,

Ground South Carolina Rock.

Valuation of Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The Organic Nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at 4½ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, than this excess of Potash is reckoned at 5½ cents per pound.

In most cases the valuation of the ingredients in Superphosphates and Specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. The charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts, and finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to $4.50 per ton.

In 1893 the average selling price of Ammoniated Superphosphates and Guanos was $32.99 per ton, the average valuation was $23.48, and the difference $9.51, an advance of 40.5 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of Special manures the average cost was $37.76, the average valuation $29.35 and the difference $8.41 or 28.6 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of nitrogen, etc., by the trade-value per pound. We thus get the

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values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone*, the sample is sifted into four grades and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton, by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

The uses of the "Valuation" are two-fold:

1. To show whether a given lot or brand of fertilizers is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for analysis cannot decide accurately what is the *form* of nitrogen, etc., while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second-named use of valuation frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth, when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of the year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

The *Agricultural value* of a fertilizer is measured by the benefits received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that Peruvian guano superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

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CLASSIFICATION OF FERTILIZERS ANALYZED.

RAW MATERIALS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

Nitrate of Soda	1
Sulphate of Ammonia	2
Dried Blood	1
Cotton Seed Meal	13
Castor Pomace	4
Horn Dust	1
Various nitrogenous matters of inferior value	8

2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*

Dissolved Bone Black	3
"Dissolved Bone"	1

3. *Containing Potash as the Chief Valuable Ingredient.*

High Grade Sulphate of Potash	6
Double Sulphate of Potash and Magnesia	1
Muriate of Potash	1

4. *Containing Nitrogen and Phosphoric Acid.*

Bone Manures	28
Tankage	6
Fish	2

MIXED FERTILIZERS.

Bone and Potash	6
Nitrogenous Superphosphates	61
Special Manures	76
Home Mixtures	5

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	34
Wood Ashes	16
Blood Albumin	1
Waste Peaches	1
Peatmoss and Swamp-Muck	4
Saltpetre Waste	2
Total	284

I. RAW MATERIALS OF HIGH GRADE CONTAINING NITROGEN AS THE CHIEF VALUABLE INGREDIENT.

NITRATE OF SODA.

Nitrate of Soda is mined in Chili and purified there before shipment. It usually contains about 16 per cent. of nitrogen, equiva-

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lent to 97 per cent. of pure nitrate of soda. It contains besides, a little salt and some moisture. The usual guarantee is "96 per cent." of nitrate of soda equivalent to 15.8 per cent. of nitrogen.

3964. From stock of L. Sanderson, New Haven.

ANALYSIS.

Moisture	3.51
Insoluble in water	.08
Sodium Chloride (Salt)	.66
Sodium Sulphate	.23
Pure Sodium Nitrate	95.52
	100.00
Equivalent Nitrogen	15.76
Cost per ton	$55.00
Nitrogen costs cents per pound	17.4

SULPHATE OF AMMONIA.

This article, now made on a large scale as a by-product of gas-works, usually contains over 20 per cent. of nitrogen, the equivalent of from 94 to 97 per cent. of sulphate of ammonia. The rest is chiefly moisture. The usual guarantee is 25 per cent. of ammonia, which is equivalent to 20.6 per cent. of nitrogen, but commercial sulphate of ammonia commonly contains less than that quantity.

3965. Stock of L. Sanderson, New Haven. **3968.** Sold by Quinnipiac Co., Boston. Stock of Olds & Whipple, Hartford.

ANALYSES.

	3965	3968
Nitrogen	20.58	20.78
Equivalent Ammonia	25.10	25.34
Cost per ton	$80.00	$75.00
Nitrogen costs cents per pound	19.4	18.1

COTTON SEED MEAL.

The seed of the cotton plant, after ginning to remove the fiber, passes through a mill which hulls or decorticates it. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer.

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Sometimes, however, hulls and seed are ground together, making "undecorticated meal" which contains considerably less nitrogen and has correspondingly less money value as a fertilizer or as a feed. When the meal has undergone heating or fermentation, its color changes from a deep yellow to brown or reddish-brown. It is then unfit for cattle food and is sold at a cheaper rate as a fertilizer.

The following analyses of Cotton Seed Meal have been made at this Station during the present year.

While they were made in the interest of those who were buying the meal to use as a fertilizer, they are worth the attention also of those who are now using or who intend during the winter season, to use Cotton Seed Meal as feed for stock.

The eight analyses which have the first place in the table represent decorticated meal of fair quality made from upland cotton.

The per cent. of nitrogen found in No. **3781** is higher than has been previously observed in any sample analyzed here, 8.08 per cent.

The per cent. of nitrogen found in No. **3832** is very low for pure meal, but the sample does not appear to be adulterated. The other differences in nitrogen, among these eight samples, are such as occur constantly and are due to differences of soil and fertilizers on which the cotton was raised and to differences in the thoroughness of the hulling.

Owing to increased foreign demand the price of cotton seed meal has advanced sharply so that it is no more our cheapest source of available nitrogen. Thus the average cost of nitrogen in these eight samples, analyzed in 1893, was 17½ cents per pound.

Last year the average cost was only about 15 cents, nevertheless meal of prime quality is still a profitable fertilizer to use if bought at $30 or even $31 per ton.

Special attention is called to the three samples, **3833, 3827** and **3856.** They contain somewhat more than half as much nitrogen and considerably less phosphoric acid and potash than the other samples, but were sold for only a dollar or two less per ton.

These are "Cotton Seed Meal" as well as the others but are made from the seed of Sea Island Cotton *ground with the hulls.* They are readily distinguished by their dark color and the presence of hard black fragments of hulls.

As fertilizers they are not worth more than $18.00 per ton when bright decorticated meal can be bought for $30.00.

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It is quite likely that this sort of meal will be put on our market more commonly than heretofore.

In ordering Meal to use as a Feed or as a Fertilizer, purchasers should require Decorticated, Upland Cotton Seed Meal containing at least 6.5 per cent. of Nitrogen, unless they are willing to use the other, greatly inferior meal, which cannot be economically done unless it can be got for a greatly reduced price.

There is no evidence that the undecorticated meal is in any way injurious to stock; indeed some feeders prefer it to the clear decorticated meal on the ground that it is less likely to cloy cattle if fed in large quantity.

But both its manurial and its feed value are much less than those of decorticated meal.

Description of Samples.

3848. Sold by A. H. Rice, Granby. Sampled by H. A. Sheldon, West Suffield.

4025. Sold by Olds & Whipple, Hartford, in the fall of 1892. Sampled by Eugene Brown, Poquonock.

3781. Bought at the south by A. Poulcur, Windsor, and sampled by him.

3881. Sold by Olds & Whipple. Sampled by Station Agent from stock of J. A. DuBon.

3858. Sold by Olds & Whipple, Hartford, in spring of 1893. Sampled by Eugene Brown, Poquonock.

3861. Sold by Edward Austin, Suffield. Sampled by O. E. Pitcher, Enfield.

3924. Sold by C. H. Dexter & Sons, Windsor Locks. Sampled by Eugene Brown and T. B. Hathaway from stock sold to several purchasers.

3832. Sold by J. H. Viets, Copper Hill. Sampled by S. D. Viets.

3833. Sold by J. H. Viets. Sampled by S. D. Viets.

3827. Sold by C. H. Dexter & Sons, Windsor Locks. Sampled by Eugene Brown, Poquonock.

3856. Sold by E. S. Hough, Poquonock. Sampled by Eugene Brown, Poquonock.

3941. Sold by Horace Griffin, East Granby. Sampled by B. L. Alderman, West Suffield.

3943. Sold by J. H. Viets, Copper Hill. Sampled by S. D. Viets.

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Analyses of Cotton Seed Meal.

	3848	4025	3781	3881	3858	3861	3924	3882	3883	3827	3856	3941	3943
Nitrogen	6.90	7.01	8.08	6.74	6.76	6.64	6.65	6.10	4.49	3.97	3.71	7.01	6.86
Phosphoric acid	3.31	3.28	2.65	3.04	3.04	3.29	3.43	3.15	1.83	1.75	1.66	---	---
Potash	1.99	1.97	1.78	1.94	1.87	1.89	2.06	1.95	1.67	1.36	1.39	---	---
Cost per ton	$26.00	27.00	30.00	27.00	30.00	30.00	31.00	30.00	28.00	29.00	29.50		
Nitrogen costs cents per pound	**14.9**	**15.4**	**15.7**	**16.2**	**18.4**	**18.5**	**19.0**	**20.2**	**27.1**	**32.4**	**35.4**		

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Castor Pomace.

The ground residue of castor beans from which castor oil has been extracted. An excellent fertilizer but extremely poisonous to cattle if they get access to it.

3807. Made by H. J. Baker & Bro., N. Y. Stock of W. F. Andross, East Hartford.

3925. Made by H. J. Baker & Bro., N. Y. Stock of F. S. Bidwell, Windsor Locks. Sampled by T. B. Hathaway, Windsor.

3826. Collier Castor Pomace, sold by F. Ellsworth. Stock bought by J. A. DuBon, Poquonock.

3808. Made by Red Seal Castor Oil Co., St. Louis, Mo. Stock of J. A. Warner, Tylerville.

Analyses.

	3807	3925	3826	3808
Nitrogen	5.39	4.58	4.62	4.40
Phosphoric Acid	1.85	1.66	1.45	1.34
Potash	1.28	1.20	1.09	1.12
Cost per ton	$24.00	$24.00	$22.00	$25.00
Nitrogen costs cents per pound	19.2	22.9	20.9	25.4

As the analyses show, the castor pomace sold this year in Connecticut has contained much less nitrogen than formerly and in consequence it has been a very expensive source of nitrogen.

Horn Dust.

4058. Made by the Salisbury Cutlery Handle Co., Salisbury. Sent by Henry Belden, Falls Village.

This sample contained 14.48 per cent. of nitrogen. It consisted partly of turnings and partly of fine horn dust. While the nitrogen of horn is by no means as available to plants as that of dried blood or fine ground bone, experiments have shown that it has considerable agricultural value. The horn may be composted with horse manure or lime. If applied to land without previous composting it should be used in the fall rather than in the spring.

Dissolved Bone Black and Dissolved Bone.

Superphosphates made by treating waste and spent bone black from the sugar refineries, or bone dust, with oil of vitriol which renders the phosphoric acid largely soluble in water.

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Dissolved Bone Black.

3993. Stock of L. Sanderson, New Haven. **3994.** Sold by Quinnipiac Co., Boston. Stock of Olds & Whipple, Hartford.

Dissolved Bone.

3739. Sold by C. E. Stagg, Stratford. Sampled and sent by S. E. Curtiss, Stratford.

ANALYSES.

	3993	3994	3739
Soluble Phosphoric Acid	16.38	12.34	6.67
Reverted " "	.35	3.46	6.72
Insoluble " "	trace	trace	1.33
Cost per ton	$26.00	27.00	16.00†
Soluble phosphoric acid costs cents per pound*	7.8	9.3	5.6

The dissolved bone black is particularly convenient to handle because it never cakes in the bag or heap.

But it will well repay those who are using any considerable quantity of phosphates to get quotations of dissolved South Carolina or Florida rock phosphate. This material, which should contain 12-14 per cent. of soluble and reverted acid, if freshly made is apt to cake on lying, but if mixed promptly with nitrogenous matter and especially if the mixture is used soon after mixing there should be no difficulty in handling it. The soluble phosphoric acid of rock phosphate is as valuable for plant food as in any other form of superphosphate and dissolved rock phosphate is very decidedly cheaper than dissolved bone black. When the available phosphoric acid of dissolved bone black costs 8 cents per pound, it can probably be got in dissolved phosphate for from 5 to 5½ cents.

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

HIGH GRADE SULPHATE OF POTASH.

This material should contain over 90 per cent. of pure sulphate of potash or about the same quantity of actual potash as the muriate, but no more than a trace of chlorine.

3797. Sold by Leander Wilcox, Mystic. Sampled by H. H. Austin, Suffield.

3862. Sold by Wm. R. Peters & Co., New York. Sampled by O. E. Pitcher, Enfield Bridge.

* Allow for reverted and insoluble phosphoric acid 6 and 2 cents per pound respectively.

† In eight ton lot.

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3896. Sold by L. Sanderson, New Haven. Sampled by W. E. Russell, Suffield.

3926. Sold by L. Sanderson, New Haven, Sampled by A. P. Hills, Silver Lane.

3963. Sold by G. B. Alderman, Suffield. Sampled by S. D. Viets, Copper Hill.

3966. Sold by Quinnipiac Co., Boston. Stock of Olds & Whipple, Hartford.

(For analyses see the table on page 24.)

Double Sulphate of Potash and Magnesia.

This material is usually sold as "sulphate of potash" or "manure salts," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27.0 per cent. of actual potash. Besides some 46–50 per cent. of sulphate of potash it contains over 30 per cent. of sulphate of magnesia, chlorine equivalent to 3 per cent. of common salt, a little sulphate of soda and lime, with varying quantities of moisture.

3927. Sold by National Fertilizer Co., Bridgeport, to G. W. & H. B. Williams, East Hartford. Sampled by A. P. Hills, Silver Lane. The goods represented by this sample were bought for high grade sulphate the price charged being $54 per ton. On receipt of the analysis showing that the goods were not high grade sulphate, the purchaser protested. The National Fertilizer Co. writes in explanation "We entered the order correctly and it was called to the factory and checked off after shipment, but for all that, the factory book now shows that the two kinds were sent as above." (A part of the invoice was high grade sulphate.) "We have explained to Messrs. Williams and sent them a 'corrected bill.'" The price finally paid was $30 per ton.

Muriate of Potash.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride) 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water.

It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of actual potash.

3967. Sold by Quinnipiac Co., Boston. Stock of Olds & Whipple, Hartford.

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ANALYSES.

	2797	2862	2896	2926	2963	2966	2927	3067
Potash soluble in water,	49.15	51.92	48.36	50.46	48.67	48.40	25.96	49.76
Equivalent sulphate of potash	90.92	96.06	89.47	93.35	90.04	89.50	48.03	....
Equivalent muriate of potash	....	....	....	....	....	....	....	79.11
Cost per ton	$55.00	$53.25	$55.00	$54.00	$59.00	$55.00	$30.00	$48.00
Potash costs cents per pound	5.58	5.13	5.68	5.35	6.6	5.7	5.8	4.8

The cost of actual potash in the samples of sulphate has been from 5.13 to 6.6 cents per pound. The high cost of potash in certain samples is explained by the abnormally low per cent. of potash in the goods, in some cases more than two per cent. lower than the average. Four out of the six samples of the high grade sulphate have less than 50 per cent. of potash.

The frequent objections of manufacturers this year to the per cent. of potash found in the various brands of mixed fertilizers may have their explanation also in this deficiency of potash in the raw material used as a source of potash.

For all crops except tobacco, sugar beets and possibly potatoes, muriate of potash is altogether the most economical source of supply.

If muriate is applied in moderate quantity in the fall or very early spring to potato land no damage to the quality or productiveness of the crop need be feared.

IV. Raw Materials containing Nitrogen and Phosphoric Acid.

Bone Manures.

The terms "Bone Dust," "Ground Bone," "Bone Meal" and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease—and if taken from garbage or ash heaps, with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam-tanks to recover grease, and are then dried and sometimes sold as "tankage;" or, finally, they apply to bone from which a

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large share of the nitrogenous substance has been extracted in the glue manufacture. The nitrogen of all these varieties of bone when they are in the same state of mechanical subdivision has essentially the same fertilizing value.

1. *Sampled by Station Agents.*

On following pages are tabulated eighteen analyses of samples of this class.

The average cost of these bone manures is $31.70 and the average valuation $32.01 per ton. This close agreement of cost and valuation in the case of bone indicates that the Station's schedule of valuation is in substantial agreement with the actual market prices.

There has been no cheaper form of readily available organic nitrogen in the market the past year than fine ground bone and tankage.

2. *Sampled by manufacturers; and* 3. *Sampled by private individuals.*

The following samples, deposited at the Station by manufacturers in compliance with the law, are analyzed to meet the requirement of the law which calls for an annual analysis of each brand. The sampling agents of the station did not succeed in finding these brands on sale in the State.

3911. Crocker's Ground Bone Meal. Made by the Crocker Fertilizer and Chemical Co., Buffalo, N. Y. Sampled by the manufacturer.

3917. Crocker's Pure Ground Bone. Sampled by the manufacturer.

3912. Lister's Celebrated Ground Bone. Made by Lister's Agricultural Chemical Works, Newark, N. J. Sampled by the manufacturer.

3860. Cooper's No. 2 Bone. Made by Peter Cooper's Glue Factory, N. Y. Sampled by O. E. Pitcher, Enfield, Conn., from stock purchased by him.

4059. Clean Bone Dust. Made by the Salisbury Cutlery Handle Co., Salisbury. Sampled and sent by Henry Belden, Falls Village.

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Bone Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
4031	Peter Cooper's Bone Dust.	Peter Cooper's Glue Factory, 17 Burling Slip, N.Y.	Geo. W. Hall, Hadlyme.	$28.00
3920	Peter Cooper's Bone Dust.	Peter Cooper's Glue Factory, 17 Burling Slip, N.Y.	Beaumont Bros., Wallingford.	27.00
3794	Ground Bone.	Reed Co., Brooklyn, N. Y.	*E. O. Wakeman, Westport.	30.00
4029	Bone Meal.	Danbury Fertilizer Co., Danbury.	Manufacturer.	30.00
3802	Ground Bone.	Florence Manufacturing Co, Florence, Mass.	*J. A. Warner, Tylerville.	35.00
4032	Pure Ground Bone.	Rogers Manufacturing Co, Rockfall.	F. Ellsworth, Hartford.	35.00
			J. A. Lewis Willimantic.	30.00
			Manufacturer.	30.00
3921	Pure Raw Ground Bone.	H. J. Baker & Bro., 93 William St., N. Y.	Saxton & Strong, Bristol.	35.00
3916	Bone Meal.	Quinnipiac Co., 92 State St., Boston, Mass.	A. P. Wakeman, Fairfield.	29.00
3919	Fine Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	W. W. Cooper, Suffield.	38 00
			H. K. Brainard, Thompsonville.	32.00
			J. A. Lewis, Willimantic.	31.00
3804	Strictly Pure Fine Bone.	The Rogers & Hubbard Co, Middletown.	E. L. Strong, Colchester.	30.00
			Geo. Butler, Cromwell.	30.00
3803	Pure Ground Raw Knuckle Bone Meal.	The Rogers & Hubbard Co., Middletown.	Geo. Butler, Cromwell.	37.00
3800	Swift-Sure Bone Meal.	M. L. Shoemaker & Co, Philadelphia, Pa.	F. Ellsworth, Hartford.	40.00
3918	Bone Fertilizer.	Plumb & Winton, Bridgeport.	Manufacturer.	30.00
3799	Fine Ground Bone.	Bradley Fertilizer Co., 92 State St., Boston, Mass.	L. F. Judson, Stratford.	32.00
			G. A. Dickenson, Haddam.	35.00
3928	Pure Ground Bone.	Peck Brothers, Northfield.	Strong & Tanner, Winsted.	30.00
3914	Pure Bone Meal.	Williams & Clark Fertilizer Co., N. Y.	N. P. Burr, Kensington.	38.00
			W. H. Smith & Co., Norwalk.	35.00
3915	Ground Bone.	Downs & Griffin, Birmingham.	Hallock & Co., Birmingham.	35.00
3913	Pure Ground Bone.	G. W. Miller, Middlefield.	Manufacturer.	28 00

* Purchaser.

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Analyses of Bone Manures.—Sampled by the Station.

Station No.	Name or Brand.	Chemical Analysis.		Mechanical Analysis.				Cost per ton.	Valuation per ton.	Percentage difference between cost and valuation.
				Finer than			Coarser than			
		Nitrogen.	Phos. Acid.	1/50 inch.	1/25 inch.	1/12 inch.	1/12 inch.			Valuation exceeds cost.
4031	Peter Cooper's Bone Dust	1.97	26 29	93	3	2	2	$28.00	$36.63	23.6
3920	Peter Cooper's Bone Dust	2.01	29 97	38	20	25	17	27.00	33.35	19.0
3794	Reed Co's Bone	1.37	31.57	47	20	21	12	30 00	35.04	14.4
4029	Danbury Fertilizer Co's Bone Meal	3.90	22.58	49	28	21	2	30.00	33.60	10.7
3802	Florence Manufacturing Co's Ground Bone	3.81	26 84	58	27	13	2	35.00	39.14	10.6
4032	Rogers Manufacturing Co's Pure Ground Bone	4.22	22.22	25	29	42	4	30.00	32.52	7 7
3921	H. J. Baker & Bro's Pure Raw Ground Bone	3.71	24.43	62	37	1	..	35.00	37.67	7.0
3916	Quinnipiac Co's Bone Meal	4.05	21.54	31	29	38	2	29.00	30.54	5.0
3919	Darling's Fine Ground Bone	2.76	22.52	68	22	10	..	32.00	32.71	2.1
3804	The Rogers & Hubbard Co's Strictly Pure Fine Bone	3.91	23.09	27	25	34	14	30.00	30.14	.4
3803	The Rogers & Hubbard Co's Pure Ground Raw Knuckle Bone Meal	4.11	25.52	37	49	14	..	37.00	37.04	.1
										Cost exceeds valuation.
3800	Shoemaker & Co's Swift-Sure Bone Meal	5.34	23.14	58	33	9	..	40.00	39 80	.5
3918	Plumb & Winton's Bone Fertilizer	3.94	21.82	35	23	24	18	30.00	29.74	.9
3799	Bradley Fertilizer Co's Fine Ground Bone	3.32	20.75	53	30	17	..	32.00	30.93	3.4
3928	Peck Brothers' Pure Ground Bone	4.22	20.60	8	21	39	32	28 00	24.68	13.5
3914	Williams & Clark's Pure Bone Meal	3.46	20.97	51	24	23	2	35.00	30.80	13.6
3915	Downs & Griffin's Ground Bone	4.47	22.07	22	23	32	23	35.00	29.03	20.6
3913	G. W. Miller's Pure Ground Bone	4.24	20.55	4	12	39	45	28.00	22.79	22.9

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MECHANICAL ANALYSES.

	3911	3917	3912	3860	4059
Fine, smaller than $\frac{1}{50}$ inch	67	41	38	50	66
Fine medium, smaller than $\frac{1}{25}$ inch	18	27	24	20	29
Medium, smaller than $\frac{1}{12}$ inch	13	26	20	18	5
Coarse, larger than $\frac{1}{12}$ inch	2	6	18	12	--
	100	100	100	100	100

CHEMICAL ANALYSES.

Nitrogen	1.76	4.08	4.36	1.52	4.39
Phosphoric acid	26.46	25.27	15.45	31.23	24.86
Valuation per ton	$33.87	35.33	25.04	35.49	40.03
Cost per ton	----	----	----	23.00	----

QUINNIPIAC BONE MEAL.

A sample of this article, No. **3806**, drawn from stock of J. W. Gardner, Cromwell, was analyzed with the results given below. The manufacturers protested that the analysis did not fairly represent the average quality of the brand and at their request an analysis was made of another sample, drawn from stock of A. P. Wakeman, Fairfield. This later analysis, No. **3916**, is tabulated with others on page 27 and is here reproduced for comparison.

MECHANICAL ANALYSES.

	3806	3916
Fine, smaller than $\frac{1}{50}$ inch	55	31
Fine medium, smaller than $\frac{1}{25}$ inch	27	29
Medium, smaller than $\frac{1}{12}$ inch	18	38
Coarse, larger than $\frac{1}{12}$ inch	--	2
	100	100

CHEMICAL ANALYSES AND VALUATIONS.

Nitrogen	3 16	4.05
Phosphoric acid	19.25	21.54
Cost per ton	$33.00	29.00
Valuation per ton	$28.96	30.54

TANKAGE.

This name is properly applied only to the sediment remaining in tanks where meat scrap with some bone is rendered to separate the fat. After boiling or superheating with steam, the fat rises to the surface of the water and is removed, the soup is run off, and the settlings at the bottom are dried and sold as tankage.

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Such material contains a percentage of nitrogen as large as or larger than that of phosphoric acid. But the name tankage is also applied to mixtures that consist largely of bone and do not differ greatly in composition from pure bone.

Sampled by Station Agent.

3801. Blood, Bone and Meat. Sold by L. Sanderson, New Haven. Sampled from stock of E. P. Carroll, East Hartford.

3805. Ground Tankage. Sold by Quinnipiac Co. Sampled from stock of Olds & Whipple, Hartford.

4026. Made by Danbury Fertilizer Co., Danbury, Ct. Stock of L. P. Russell, Orange.

MECHANICAL ANALYSES.

	3801	3805	4026
Fine, smaller than $\frac{1}{10}$ inch	47	62	47
Fine medium, smaller than $\frac{1}{5}$ inch	29	22	23
Medium, smaller than $\frac{1}{2}$ inch	20	16	17
Coarse, larger than $\frac{1}{2}$ inch	4	--	13
	100	100	100

CHEMICAL ANALYSES AND VALUATIONS.

Nitrogen	7.07	4.53	5.13
Phosphoric acid	9.59	19.15	16.71
Cost per ton	$35.00	32.00	30.00
Valuation per ton	$27.65	33.03	29.41

DRY GROUND FISH.

This material is often mixed with oil of vitriol to hinder decay during drying, and the bones of the fish are as a result dissolved to some extent.

3992. Made by the Quinnipiac Co. Sampled from stock of Olin Wheeler, Buckland, and Olds & Whipple, Hartford.

ANALYSIS.

	3992
Nitrogen as ammonia	.25
Organic Nitrogen	8.44
Soluble phosphoric acid	.66
Reverted phosphoric acid	4.22
Insoluble phosphoric acid	2.17
Cost per ton	$40.00
Valuation per ton	$37.19

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Mixed Fertilizers.

I. Bone and Potash.

The following brands, though sold under a variety of names, consist of bone or tankage mixed with potash salts.

3750. "Ground Bone." Made by Preston Fertilizer Co., Greenpoint, N. Y. Stock of F. M. Raymond, Westport.

3997. Circle Brand Bone and Potash. Made by Bradley Fertilizer Co., Boston. *Manufacturer's sample.*

4004. "Self-recommending Fertilizer." Made by F. Nuhn, Waterbury. Sampled by Station agent.

4006. "Ground Bone." Made by E. F. Coe, N. Y. Sampled by Station agent from stock of Wheeler & Howe, Bridgeport, and J. O. Fox, Putnam.

Mechanical Analyses.

	3750	3997	4004	4006
Fine, smaller than $\frac{1}{50}$ inch	37	54	45	31
Fine medium, smaller than $\frac{1}{25}$ inch	28	31	28	24
Medium, smaller than $\frac{1}{12}$ inch	26	15	18	18
Coarse, larger than $\frac{1}{12}$ inch	9	--	9	27
	100	100	100	100

Chemical Analyses.

Nitrogen	3.52	2.49	3.57	2.87
Phosphoric acid	7.33	18.52	21.10	20.24
Potash	3.50	3.04	2.09	3.31
Cost per ton	$29.00	....	28.00	32.50
Valuation per ton	$19.40	29.26	32.19	28.24

Two samples of G. W. Miller's Bone Phosphate were drawn and sent for analysis by D. W. Patten, Clintonville, from stock shipped directly from the manufacturer to Clintonville.

3851 cost $37.00 per ton and had a minimum guarantee of 4.66 per cent. nitrogen, 4.9 per cent. potash, and 12.50 per cent. phosphoric acid.

3852 cost $36.00 and was guaranteed to contain 3.5 per cent. of nitrogen, 4.5 of potash and 11.0 of phosphoric acid.

The percentages found were as follows:

	3851	3852
Nitrogen as nitrates	1.30	1.75
as ammonia	.20	.17
organic	1.90	1.31
Total nitrogen	3.40	3.23
Total phosphoric acid	9.67	10.41
Total Potash	6.48	4.51

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II. Nitrogenous Superphosphates and Guanos.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on.

1. *Samples drawn by Station agents.*

In the tables on pages 32 to 39 are tabulated the analyses of forty-nine brands, made on samples collected by the Station agents.

Notes on Particular Analyses.

No. **3815,** Farmers' New Method Fertilizer, made by the Bradley Fertilizer Co., Boston, Mass., was objected to by the manufacturer on account of the low percentage of potash. It represented a mixture of samples from the stock of Wilson & Burr, Middletown, L. F. Judson, Stratford, W. F. Andross, East Hartford, D. N. Clark & Sons, Milford. On account of this protest another sample of this brand was drawn, No. **3950,** the analysis of which is given in the table on page 38 and is here reproduced for comparison.

Analyses of Bradley's Farmers' New Method Fertilizer.

	3815	3950
Total nitrogen	2.25	2.30
Phosphoric acid	11.32	11.03
Potash	2.42	2.68
Valuation	$23.45	23.48

Neither of these analyses shows the quantity of potash claimed by the manufacturer. A possible explanation of this discrepancy is given on page 24.

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NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3888	Standard UnXLD Fertilizer.	H. J. Baker & Bro., 93 William St., N. Y. City.	W. F. Andross, East Hartford	$32.00
3874	Farm and Garden, or Ammoniated Bone Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Henry Davis, Durham Center.	32.00
			E. B. Clark & Sons, Milford.	29.00
			B. Curtiss & Son, Stepney.	33.00
			J. E. Leonard, Jewett City.	32.00
			E. L. Strong, Colchester.	31.00
			J. A. Lewis, Willimantic.	32.00
3974	Vegetable, Vine and Fruit Fertilizer.	Read Fertilizer Co., Box 3121, N. Y. City.	B. F. Silliman, New Canaan.	38.00
			G. B. Alderman, Suffield.	37.00
3908	King Philip Alkaline Bone.	Clark's Cove Fertilizer Co., State St., Boston, Mass.	P. Platt, Milford.	30.00
			J. M. Burke, South Manchester.	26.00
			H. H. Davenport, Pomfret.	27.00
3884	Russell Coe's Phosphate.	National Fertilizer Co., Bridgeport.	T. E. Eldridge, Norwich.	34.00
3977	Fish, Bone and Potash.	Read Fertilizer Co., Box 3121, N. Y. City.	S. F. Palmer, Jewett City.	32.00
			G. B. Alderman, Suffield	32.00
			Waldo Tillinghast, Plainfield.	29.00
			B. F. Silliman, New Canaan.	33.00
3940	Fish and Potash, Triangle A. Brand.	Bradley Fertilizer Co., 92 State St, Boston. Mass.	Carter & Strong, Manchester.	31.00
3902	New Rival Ammoniated Superphosphate.	Crocker Fertilizer & Chemical Co, Buffalo, N. Y.	E. H. Talcott, Torrington.	32.00
3978	Pine Island Phosphate.	Quinnipiac Co., 92 State St., Boston, Mass.	Olin Wheeler, Buckland.	34.00
3954	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co., 92 State St., Boston, Mass.	Olin Wheeler, Buckland.	35.00
			Olds & Whipple, Hartford.	34.00
3990	Pilgrim Fertilizer.	J. S. Reese & Co., 10 South St., Baltimore, Md	W. H. Anderson, Putnam.	32.00
3976	Standard Phosphate.	Read Fertilizer Co., Box 3121, N. Y. City.	F & F. W. Tillinghast, Central Village.	32.00
			Waldo Tillinghast, Plainfield.	29.00
			S. F. Palmer, Jewett City.	32.00

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Analyses of Nitrogenous Superphosphates and Guanos Sampled by the Station.

Station No.	Name or Brand.	Nitrogen					Phosphoric Acid.							Potash.			Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	As Muriate.	Total. Found.	Total. Guaranteed.			
3798	Mapes' Fine Dissolved Bone	....	....	3.13	3.13	*2.1*	2.66	14.06	3.72	20.44	....	16.72	*12.0*	....	....	....	$33.00	$32.78	.7
3961	Preston's Ammoniated Bone Phosphate	....	.19	3.03	3.22	*2.5*	5.46	3.94	1.63	11.03	....	9.40	*9.0*	1.53	3.27	*2.0*	31.00	27.03	14.7
4028	Danbury Fertilizer Co's Nameless Fertilizer	....	.78	2.30	3.08	*2.1*	1.57	6.27	2.71	10.55	*8.0*	7.84	....	5.21	5.21	*3.0*	30.00	26.03	15.3
3934	Mapes' Complete Manure for General Use	.38	1.48	1.77	3.63	*3.3*	7.23	3.95	.97	12.15	*10.0*	11.18	*8.0*	5.01	5.01	*4.0*	38.00	31.45	20.8
3837	Shoemaker's Swift Sure Superphosphate	.66	....	2.23	2.89	*2.5*	9.17	2.79	2.43	14.39	*14.0*	11.96	*9.0*	....	4.72	*4.0*	38.00	31.29	21.4
3933	Mapes' Complete Manure A Brand	.32	.62	2.18	3.12	*2.5*	8.72	3.19	.73	12.64	*12.0*	11.91	*10.0*	3.06	3.06	*2.5*	36.00	28.94	24.4
3937	Lister's Ammoniated Dissolved Bone	....	35	1.70	2.05	*1.7*	6.59	2.55	1.93	11.07	*11.0*	9.14	*9.0*	1.94	1.94	*1.5*	27.00	21.29	26.8
3970	Sanderson's Formula A	.68	.06	2.44	3.18	*3.3*	4.61	3.12	2.45	10.18	*10.0*	7.73	*6.0*	4.85	6.12	*6.0*	35.00	27.35	27.9
3880	Wilcox's Ammoniated Bone Phosphate No. 1	....	.17	2.65	2.82	*2.5*	4.32	2.84	2.10	9.26	*7.0*	7.16	*6.0*	5.43	5.43	*5.0*	32.00	24.62	30.0
3991	Reese's New England Favorite	....	.82	1.93	2.75	*2.5*	5.04	5.13	.19	10.36	*11.0*	10.17	*9.0*	2.69	2.69	*2.0*	33.00	24.76	33.3
3816	Coe's Ammoniated Bone Phosphate	....	.74	1.43	2.17	*2.1*	7.30	2.36	2.34	12.00	*9.0*	9.66	*7.0*	.20	2.74	*1.9*	32.00	23.76	34.7
3869	Bowker's Hill and Drill Phosphate	1.06	....	1.74	2.80	*2.5*	7.46	2.89	3.35	13.70	*12.0*	10.35	*10.0*	2.25	2.25	*2.0*	35.00	25.92	35.0
3935	Lister's Standard Superphosphate	....	.37	2.00	2.37	*2.3*	8.17	2.02	1.81	12.00	*12.0*	10.19	*10.0*	1.78	1.78	*2.0*	32.00	23.63	35.4
3883	Chittenden's Ammoniated Bone Superphosphate	....	....	2.54	2.54	*1.7*	4.51	3.88	3.06	11.45	....	8.39	*7.0*	3.29	3.29	*2.0*	32.00	23.59	35.6
3972	Wilcox's Ammoniated Bone Phosphate No. 2	....	....	2.07	2.07	*1.6*	5.86	3.62	1.71	11.19	*10.0*	9.48	*9.0*	2.47	2.47	*2.0*	30.00	22.12	35.6

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ANALYSES OF NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.			Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	As Muriate.	Total. Found.	Total. Guaranteed.			
3889	Baker's A. A. Superphosphate	.23	2.01	.61	2.85	*2.5*	9.70	1.72	.80	12.22	*11.0*	11.42	*10.0*	3.21	3.21	*2.0*	$37.50	$27.56	36.0
3907	Clark's Cove Bay State Fertilizer	....	....	2.39	2.39	*2.3*	7.28	2.53	1.10	10.91	*10.0*	9.81	*8.5*	2.12	2.12	*2.0*	32.00	23.22	37.8
3903	Crocker's Ammoniated Superphosphate	....	....	3.20	3.20	*2.9*	7.30	2.43	1.07	10.80	*10.0*	9.73	*9.0*	1.37	1.37	*1.0*	35.00	25.27	38.4
3814	Bradley's Superphosphate	.22	.16	2.42	2.80	*2.3*	7.42	3.00	1.41	11.83	*11.0*	10.42	*9.0*	1.95	1.95	*1.5*	35.00	25.26	38.6
3895	Bradley's Sea Fowl Guano	....	....	2.30	2.30	*2.1*	6.98	3.43	2.23	12.64	*10.0*	10.41	*8.0*	1.87	1.87	*1.5*	33.00	23.81	38.6
3893	Bowker's Sure Crop Phosphate	.06	....	.97	1.03	*.8*	7.02	3.22	2.46	12.70	*10.0*	10.24	*8.0*	1.00	1.00	*1.0*	28.00	20.13	39.1
3812	Americus Ammoniated Superphosphate	....	....	2.62	2.62	*2.5*	6.67	3.62	1.06	11.35	*10.0*	10.29	*9.0*	1.83	1.83	*2.0*	34.00	24.25	40.2
3950	Bradley's New Method Fertilizer	....	....	2.30	2.30	*1.7*	7.31	2.54	1.18	11.03	*10.0*	9.85	*8.0*	2.68	2.68	*3.0*	33.00	23.48	40 5
3960	Quinnipiac Fish and Potash, Plain Brand	....	.16	2.28	2.44	*2.1*	3.15	2.90	.93	6.98	*8.0*	6.05	*4.0*	5.14	5 14	*4.0*	30.00	21.10	42.1
3952	Quinnipiac Amm'd Dissolved Bone	....	....	1.91	1.91	*2.0*	4.41	6.04	3.60	14.05	*10.0*	10.45	*9.0*	.48	1.93	*2.0*	33.00	23.14	42.6
3975	Read's High Grade Farmer's Friend	....	.12	3 45	3.57	*3.3*	2.83	2.26	1.73	6.82	....	5.09	*5.0*	9.14	9.14	*10.0*	40.00	27.80	43.9
3904	Crocker's Practical Phosphate	....	....	2.13	2.13	*1.0*	5.78	3.41	1.30	10.49	*8.0*	9.19	*8 0*	1.29	1.29	*1.0*	30.00	20.74	44.6
3886	Coe's High Grade Fish and Potash	....	....	2.73	2.73	*3.0*	3.46	3.07	3.13	9.66	*6.0*	6.53	*4.0*	1.88	1.88	*2.7*	30.00	20.67	45.1
3899	Cumberland Superphosphate	....	....	2.54	2.54	....	7.23	2.42	1.33	10.98	....	9.65	*8 0*	1.85	1.85	*4.0*	34 00	23.40	45.3
3818	Quinnipiac Phosphate	....	.16	2.48	2.64	*2 5*	6.90	3.56	1.23	11.69	*10.0*	10.46	*9.0*	1.91	1.91	*2.0*	36.00	24 67	45.9
3891	Baker's Harvest Home Phosphate	....	.89	.67	1.56	*.8*	4.80	4.03	2.24	11.07	....	8.83	*8.0*	2.71	2.71	*2.0*	29.00	19.80	46.5

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ANALYSES OF NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION.—*Concluded.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.					
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		As Muriate.	Total.		Cost per Ton.	Valuation per Ton.	Percentage Difference between Cost and Valuation.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		Found.	Guaranteed.			
3885	Chittenden's Fish and Potash	....	....	2.91	2.91	*3.3*	1.81	1.67	4.25	7.73	*6.0*	3.48	....	.92	5.25	*5.0*	$32.00	$21.84	46.5
3939	Darling's Animal Fertilizer	.41	.21	2.70	3.32	*3.3*	3.28	4.06	2.00	9.34	*10 0*	7.34	*6.0*	3.38	3.38	*4.0*	36.00	24.42	47.4
3971	Wilcox's Fish and Potash	....	.33	3.16	3.49	*3.3*	3.15	2.37	1.09	6.61	*6.0*	5.52	*5 0*	4.64	4.64	*4.0*	35.00	23.74	47.4
3877	Soluble Pacific Guano	....	....	2.61	2.61	*2 3*	6.72	3.01	1.21	10.94	*10.5*	9.73	*8 5*	1.91	1.91	*2.0*	35.00	23.69	47.7
3876	Coe's Alkaline Bone	....	.12	1.32	1.44	*1.0*	6.88	2.73	2.39	12.00	*9.0*	9.61	*9.0*	....	2.48	*3.0*	31.00	20.94	48.1
3900	Chicopee Farmer's Reliable Fertilizer	....	.37	1.76	2.13	*1.7*	6.27	3.17	1.54	10.98	*10.0*	9.44	*8 0*	1.29	1.62	*2.0*	32.00	21.52	48.7
3888	Baker's Standard UnXLD Fertilizer	....	1.11	.98	2.09	*1.9*	7.04	1.73	.90	9.67	....	8.77	*8.0*	2.97	2.97	*2.3*	32.00	21.47	49.0
3874	Bowker's Farm and Garden Phosphate	.67	....	1.22	1.89	*1.5*	7.89	1.56	2.15	11.60	*10.0*	9.45	*8.0*	2.15	2.15	*2 0*	32.00	21.28	50.3
3974	Read's Vegetable, Vine and Fruit Fertilizer	.09	....	2.23	2.32	*1.6*	4 08	3.30	1.28	8.66	*7.0*	7.38	*6.0*	7.28	7.28	*8.0*	37.00	24.42	51.5
3908	Clark's Cove Co's King Philip Alkaline Bone	....	....	1.34	1.34	*1.5*	6.08	2.14	1.29	9.51	*7.0*	8.22	*6.0*	2.32	2.32	*3 0*	27.00	17.78	51.8
3884	National Fertilizer Co's Russell Coe's Phosphate	....	.28	2.00	2.28	*1.7*	2.53	4.55	4.13	11.21	*9 0*	7.08	*8.0*	4.25	4.25	*1.0*	34.00	22.18	53.2
3977	Read's Fish, Bone and Potash	.28	.12	2.36	2.76	*2.5*	2.30	2.10	1.33	5.73	*6.0*	4.40	*4 0*	5.87	5.87	*4.0*	32.00	20.86	53.4
3940	Bradley's Fish and Potash, Triangle A. Brand	....	.15	2.31	2.46	*2.0*	2.82	3.07	1.12	7.01	*6.0*	5.89	*4.0*	3.98	3.98	*4.0*	31.00	19.98	55.1
3902	Crocker's New Rival Superphosphate	....	....	1.35	1.35	*1.2*	5.89	3.80	1.99	11.68	*11.0*	9.69	*10.0*	1.84	1.84	*1.8*	32.00	19.41	64.9
3978	Quinnipiac Pine Island Phosphate	....	.12	1.98	2.10	*2.5*	5.01	3.78	2.10	10.89	*10.0*	8.79	*9.0*	1.37	1.37	*1.0*	34.00	20.46	66.1
3954	Quinnipiac Fish and Potash, Crossed Fishes Brand	....	.37	2.73	3.10	*3 3*	.27	3.58	3 80	7.65	*5.0*	3.85	*3.0*	3.99	3.99	*3.0*	35.00	20.58	70 0
3990	Reese's Pilgrim Fertilizer	....	.08	1.31	1.39	*1.2*	4.16	4.42	.78	9.36	*7 5*	8.58	*6.5*	2.94	2.94	*3.0*	32.00	18.53	72.7
3976	Read's Standard Phosphate	....	....	1.17	1.17	*.8*	4.85	2.99	1.47	9.31	*10.0*	7.84	*8.0*	4.16	4.16	*4 0*	32.00	18.33	74.6

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The Guarantees.

The law of Connecticut requires every package of fertilizer to bear a statement of the actual composition of the goods. This usually expresses the quantities of nitrogen, phosphoric acid and potash within certain limits, as "nitrogen 2–4 per cent."

If a fertilizer with such a guarantee actually contains 2 per cent. of nitrogen, it is within the manufacturer's guarantee.

It is the lowest figures of the guarantee therefore that purchasers should regard.

Of the forty-nine brands here reported seventeen are below their minimum guarantee in respect of one ingredient, and three in respect of two ingredients. That is, considerably more than one-third of all the nitrogenous superphosphates in our market contain less of one or of two ingredients than they are claimed to contain.

It is urged that an excess of one ingredient over the guarantee should be held to make good the deficiency of another. But with reasonable care and skill in the manufacture and in the sampling and analysis of the goods the actual analysis should not fall below the minimum guaranteed in any respect particularly when wide limits are allowed in the guarantees themselves.

Cost and Valuation.

Cost.

The method used to ascertain the retail cash price of the phosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis when done is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

From these data the average prices are computed.

Valuation.

The valuation has been computed in all cases in the usual manner.

Percentage Difference given in the last column of the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid and potash contained in the fertilizer.

This information puts the purchaser in a position where he can figure as to the probable relative value of the different brands and the probable relative economy of buying fertilizers mixed or unmixed.

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Which method of buying is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

No general rule can be given. In one case ready-mixed, in another, home-mixed fertilizers may be found the more profitable to use.

The average cost of the nitrogenous superphosphates is $32.99. The average valuation, $23.48, and the percentage difference 40.5.

Last year the corresponding figures were :

Average cost $34.80, Average valuation $26.25, Percentage difference 32.6.

2. *Sampled by Manufacturers and* 3. *Sampled by private individuals.*

(For tabulated analyses see page 42.)

2. *Sampled by Manufacturers.*

These samples were sent to the Station in compliance with the terms of the Fertilizer Law and were analyzed because no samples of the brands named were found in market by our sampling agents:

3987. Anchor Brand Fish and Potash. Made by the Bradley Fertilizer Co., Boston.

3999. Original Coe's Superphosphate. Made by the Bradley Fertilizer Co.

3984. Vegetable Bone Superphosphate. Made by the Crocker Fertilizer and Chemical Co. Buffalo, N. Y.

3983. Bone, Fish and Potash. Made by E. R. Kelsey, Branford.

3986. Lister's "Success" Fertilizer. Made by Lister Fertilizer Chemical Works, Newark, N. J.

4000. Banner Fertilizer. Made by Walker, Stratman & Co., Pittsburg, Pa.

4001. Four Fold Fertilizer. Made by Walker, Stratman & Co.

3. *Sampled by private individuals.*

3834. "Conn. Valley Orchard Co's Fertilizer." Made by Quinnipiac Co., New York. Sampled by Conn. Valley Orchard Co., New Britain.

3774. G. W. Miller's Flour of Bone Phosphate. Made by G. W. Miller, Middlefield. Sampled by C. P. Augur, Middlefield.

3942. Sanderson's Formula A. Made by L. Sanderson, New Haven. Sampled by Josiah Hawkins, Southport.

4011. Sanderson's Formula A. Made by L. Sanderson, New Haven. Sampled by W. S. Clark, Stephenson.

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Analyses and Valuations.

	3987	3999	3984	3983	3986	4000	4001	3834	3774	3942	4011
Nitrogen as nitrates	....	.13	....	....	....	....	....	.65	1.22	.82	.20
as ammonia	....	....	....	.66	.25	....	....	.45	.26	.06	.08
organic	3.53	2.30	4 67	2.69	1.22	1.62	1.27	2.44	1.83	2.35	2.55
Total nitrogen found	3.53	2.43	4.67	3.35	1.47	1.62	1.27	3.54	3.31	3.23	2.83
Nitrogen guaranteed	**2.2**	**1.7**	**5.0**	**3.3**	**1.0**	**2.0**	**1.6**	....	....	**3.2**	**3.2**
Phosphoric acid, soluble	3.12	6.90	5.54	2.86	5.34	6.69	5.86	4.48	7.36	4.82	3.52
reverted	2.84	3.26	2.08	3.19	3.20	1.80	1.90	3.22	2.33	2.94	3.70
insoluble	2.10	1.48	.93	1.56	2.62	4.41	3.91	2.28	1.02	1.95	2.48
Total phosphoric acid found	8.06	11.64	8 55	7.61	11.16	12.90	11.67	9.98	10.71	9.71	9.70
Phosphoric acid guaranteed	**5.0**	**12.0**	**7.0**	**4.0**	....	**11.0**	**10.0**	....	....	....	....
"Available" phosphoric acid found	5.96	10.16	7.62	6.05	8.54	8.49	7.76	7.70	9.69	7.76	7 22
Available phosphoric acid guaranteed	**3.0**	**10.0**	**6.0**	....	**10.5**	**9.0**	**8.0**	....	....	**6.00**	**6.0**
Potash	3.81	1.53	6.87	3.65	1.56	2.11	7.02	2.26	4.51	6.99	6.89
Potash guaranteed	**3.0**	**1.0**	**6 0**	**3.0**	**1.5**	**1.0**	**2.0**	....	....	**6.00**	**6.0**
Valuation per ton	$24.26	23 07	32.60	23.82	18.36	20.29	22.23	24.71	27.91	27.83	26.71

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III. Special Manures.

1. *Sampled by Station Agents.*

For Analyses and Valuations see pages 44 *to* 51.

Here are included such Nitrogenous Superphosphates as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

Notice of Particular Analyses.

The following analyses are here tabulated by themselves, because in each case the manufacturer protested that the analysis did not represent the average quality of the brand as it was sold in this State.

The Station endeavored in each case to obtain other samples of the goods for analysis, but was not able to secure them in all cases. The Station does not consider itself at liberty to withhold such analyses from publication altogether, but prints them in connection with the manufacturer's statement or protest. It is quite possible that improper storage may alter considerably the composition of a fertilizer, and in cases where the retailer re-bags a given brand of goods there is a possibility that the new bags may bear another brand, and thus make confusion in the sampling. For these and other reasons the Station has in all cases where it has been asked, and has been possible, repeated the analysis on new samples.

3892. Tobacco Manure, made by H. J. Baker & Bro., N. Y. City. It is claimed by the manufacturer that this brand contains at least 5 per cent. more potash and less chlorine than our analysis shows. A new sample of this brand, No. **3951,** was drawn from stock of Strong & Tanner, Winsted. The analysis of this is given on page 49, and is here reproduced for comparison. It contains over two per cent. more of potash than No. **3892.**

3910. Complete Onion Manure, made by H. J. Baker & Bro., N. Y. City. It is stated by the manufacturers that the analysis conforms exactly to that of their complete Potato Manure but shows one per cent. less nitrogen and five per cent. more potash than their Onion Manure contains.

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Special Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3996	Seeding Down Manure.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes Branch, Hartford.	$37.50
3809	Grass and Grain Fertilizer.	Rogers & Hubbard Co., Middletown.	E. L. Strong, Colchester.	36.50
			George S. Butler, Cromwell.	37.50
4027	Tobacco Manure.	Danbury Fertilizer Co., Danbury.	Manufacturer.	35.00
3989	Soluble Potato Manure.	Rogers & Hubbard Co., Middletown.	E. L. Strong, Colchester.	38.00
4030	Potato Fertilizer.	Danbury Fertilizer Co, Danbury.	S. D. Woodruff & Sons, Orange.	36.00
			T. P. Russell, Orange.	35.00
			Raymond Bros., South Norwalk.	33.00
3875	High Grade Tobacco Manure.	Bradley Fertilizer Co, 92 State St., Boston, Mass.	Carter & Strong, Manchester.	48.00
			H. K. Brainard, Thompsonville.	46.00
			A. C. Sternberg, Hartford.	48.00
3872	Stockbridge Manure for Tobacco.	Bowker Fertilizer Co., 43 Chatham St, Boston, Mass.	J. Fred. Hutchinson, Windsor.	50.00
			J. C. Collins, Wapping.	50.00
3858	Connecticut Wrapper Fertilizer. Pinney's Formula.	Cleveland Linseed Oil Co., Cleveland, O.	H. O. Warner, New Milford.	38.00
			Geo. E. Pierce, Roxbury.	38.00
3951	Special Tobacco Manure.	H. J. Baker & Bro., 93 William St., N.Y.	Strong & Tanner, Winsted.	39.00
3932	Fruit and Vine Manure.	Mapes' F. & P. G. Co., N. Y.	Birdsey & Foster, Meriden.	39.00
3931	Tobacco Starter.	Mapes' F. & P. G. Co., N. Y.	S. T. Welden, Simsbury.	35.00
			Southington Lumber and Feed Co., Southington.	40 00
3995	Wrapper Brand Tobacco Manure.	Mapes' F. & P. G. Co, N. Y.	Mapes Branch, Hartford.	48.00
3929	Grass & Grain Spring Top Dressing	Mapes' F. & P. G. Co., N. Y.	Mapes Branch, Hartford.	39.00
			F. S. Bidwell, Windsor Locks.	40.00
			J. P. Barstow & Co., Norwich.	40.00
			Birdsey & Foster, Meriden.	40.00
			Jno. H. Ray & Son, Greenwich.	43.00

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SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3839	Manure for Corn.	Mapes' F. & P. G. Co., N. Y.	Mapes Branch, Hartford.	$39.00
			C. W. Beardsley, Milford.	41.00
			E. W. Pierce & Co., Plainville.	41.00
			J. P. Barstow & Co., Norwich.	40.00
3845	Stockbridge Manure for Potatoes and Vegetables.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	C. H. Bell, Portland.	38.00
			City Coal & Wood Co., New Britain.	37.00
			E. L. Strong, Colchester.	37.00
			J. F. Hutchinson, Windsor.	41.00
			H. K. Brainard, Thompsonville.	38.00
3890	Potato Manure.	H. J. Baker & Bro., N. Y.	E. F. Hawley, Newtown.	40.00
			H. K. Brainard, Thompsonville.	40.00
			W. F. Andross, E. Hartford.	43.00
3835	Complete Manure for Light Soils.	Mapes' F. & P. G. Co, N. Y.	J. P. Barstow & Co., Norwich.	43.00
			C. W. Beardsley, Milford.	44.00
			Mapes Branch, Hartford.	42.00
			Wilson & Burr, Middletown.	43.00
3840	Manure for Potatoes.	Mapes' F. & P. G. Co., N. Y.	Mapes Branch, Hartford.	41.00
			Wilson & Burr, Middletown.	42.00
			C. W. Beardsley, Milford.	43.00
			F. S. Bidwell, Windsor Locks.	42.00
			E. N. Pierce & Co., Plainville.	43.00
			W. W. Cooper, Suffield.	43.00
			J. P. Barstow & Co., Norwich.	42.00
3887	Complete Corn Manure.	H J. Baker & Bro., N. Y.	W. F. Andross, E. Hartford.	38.00
3873	Potato, Onion and Tobacco Manure.	L. Wilcox, Mystic.	W. C. Reynolds, Goodspeeds.	36.00
			Fred. Gallup, N. London	35.00
			Manufacturer.	36.00
			Waldo Tillinghast.	34.00
3873	Stockbridge Manure for Top Dressing.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. M. Williams, Manchester.	40.00
			J. A. Lewis, Willimantic.	40.00
			J. F. Hutchinson, Windsor.	41.00
			H. K. Brainard, Thompsonville.	38.00

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Special Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3996	Seeding Down Manure.	Mapes' Formula and Peruvian Guano Co., New York.	Mapes Branch, Hartford.	$37.50
3809	Grass and Grain Fertilizer.	Rogers & Hubbard Co., Middletown.	E. L. Strong, Colchester.	36.50
			George S. Butler, Cromwell.	37.50
4027	Tobacco Manure.	Danbury Fertilizer Co., Danbury.	Manufacturer.	35.00
3989	Soluble Potato Manure.	Rogers & Hubbard Co., Middletown.	E. L. Strong, Colchester.	38.00
4030	Potato Fertilizer.	Danbury Fertilizer Co, Danbury.	S. D. Woodruff & Sons, Orange.	36.00
			T. P. Russell, Orange.	35.00
			Raymond Bros., South Norwalk.	33.00
3875	High Grade Tobacco Manure.	Bradley Fertilizer Co, 92 State St., Boston, Mass.	Carter & Strong, Manchester.	48.00
			H. K. Brainard, Thompsonville.	46.00
			A. C. Sternberg, Hartford.	48.00
3872	Stockbridge Manure for Tobacco.	Bowker Fertilizer Co., 43 Chatham St, Boston, Mass.	J. Fred. Hutchinson, Windsor.	50.00
			J. C. Collins, Wapping.	50.00
3858	Connecticut Wrapper Fertilizer. Pinney's Formula.	Cleveland Linseed Oil Co., Cleveland, O.	H. O. Warner, New Milford.	38 00
			Geo. E. Pierce, Roxbury.	38.00
3951	Special Tobacco Manure.	H. J. Baker & Bro., 93 William St., N.Y.	Strong & Tanner, Winsted.	39.00
3932	Fruit and Vine Manure.	Mapes' F. & P. G. Co., N. Y.	Birdsey & Foster, Meriden.	39.00
3931	Tobacco Starter.	Mapes' F. & P. G. Co., N. Y.	S. T. Welden, Simsbury.	35.00
			Southington Lumber and Feed Co., Southington.	40 00
3995	Wrapper Brand Tobacco Manure.	Mapes' F. & P. G. Co, N. Y.	Mapes Branch, Hartford.	48.00
3929	Grass & Grain Spring Top Dressing	Mapes' F. & P. G. Co., N. Y.	Mapes Branch, Hartford.	39.00
			F. S. Bidwell, Windsor Locks.	40.00
			J. P. Barstow & Co., Norwich.	40.00
			Birdsey & Foster, Meriden.	40.00
			Jno. H. Ray & Son, Greenwich.	43.00

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SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3839	Manure for Corn.	Mapes' F. & P. G. Co., N. Y.	Mapes Branch, Hartford.	$39.00
			C. W. Beardsley, Milford.	41.00
			E. W. Pierce & Co., Plainville.	41.00
			J. P. Barstow & Co., Norwich.	40.00
3845	Stockbridge Manure for Potatoes and Vegetables.	Bowker Fertilizer Co., 43 Chatham St, Boston, Mass.	C. H. Bell, Portland.	38.00
			City Coal & Wood Co., New Britain.	37.00
			E. L. Strong, Colchester.	37.00
			J. F. Hutchinson, Windsor.	41.00
			H. K. Brainard, Thompsonville.	38.00
3890	Potato Manure.	H. J. Baker & Bro., N. Y.	E. F. Hawley, Newtown.	40.00
			H. K. Brainard, Thompsonville.	40.00
			W. F. Andross, E. Hartford.	43.00
3835	Complete Manure for Light Soils.	Mapes' F. & P. G. Co, N. Y.	J. P. Barstow & Co., Norwich.	43.00
			C. W. Beardsley, Milford.	44.00
			Mapes Branch, Hartford.	42.00
			Wilson & Burr, Middletown.	43.00
3840	Manure for Potatoes.	Mapes' F. & P. G. Co., N. Y.	Mapes Branch, Hartford.	41.00
			Wilson & Burr, Middletown.	42.00
			C. W. Beardsley, Milford.	43.00
			F. S. Bidwell, Windsor Locks.	42.00
			E. N. Pierce & Co., Plainville.	43.00
			W. W. Cooper, Suffield.	43.00
			J. P. Barstow & Co., Norwich.	42.00
3887	Complete Corn Manure.	H J. Baker & Bro., N. Y.	W. F. Andross, E. Hartford.	38.00
3973	Potato, Onion and Tobacco Manure.	L. Wilcox, Mystic.	W. C. Reynolds, Goodspeeds.	36.00
			Fred. Gallup, N. London	35.00
			Manufacturer.	36.00
			Waldo Tillinghast.	34.00
3873	Stockbridge Manure for Top Dressing.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. M. Williams, Manchester.	40.00
			J. A. Lewis, Willimantic.	40.00
			J. F. Hutchinson, Windsor.	41.00
			H. K. Brainard, Thompsonville.	38.00

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SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3953	Havana Tobacco Fertilizer.	Quinnipiac Co., 92 State St., Boston, Mass.	J. W. Gardner, Cromwell.	$48.00
3879	High Grade Special for Potatoes, Tobacco, etc.	Williams & Clark Fertilizer Co., 71 Fulton St., N. Y.	Dan. Morgan, Poquonock.	39.00
			J. G. Grant, Wapping.	40.00
			S. D. Woodruff & Sons, Orange.	37.00
			John Bransfield, Portland.	40.00
3936	Potato Manure.	Lister's Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	38.00
3905	Special Potato Manure.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	J. C. Lincoln, Berlin.	38.00
			W. H. Anderson, Putnam.	38.00
3871	Stockbridge Manure for Potatoes.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. A. Lewis, Willimantic.	40.00
			City Coal & Wood Co., New Britian.	37.00
			W. F. Andross, E. Hartford.	40.00
			F. Hallock & Co., Birmingham.	38.00
			J. M. Williams, Manchester.	40.00
			W. H. Anderson, Putnam.	40.00
			E. B. Clark & Sons, Milford.	38.00
3886	Complete Manure for Corn & Grain	Bradley Fertilizer Co., Boston, Mass.	D. N. Clark & Sons, Milford.	39.00
			M. Beach & Son, New Milford.	40.00
3844	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston, Mass.	L. F. Judson, Stratford.	38.00
			Bulkley & Tanner, Wethersfield.	40.00
			H. K. Brainard, Thompsonville.	38.00
			R. A. Parker, Warehouse Point.	38.00
3813	Potato Manure.	Bradley Fertilizer Co., Boston, Mass.	L. F. Judson, Stratford.	37.00
			Wilson & Burr, Middletown.	36.00
			A. C. Sternberg, Hartford.	35 00
			Bulkley & Hanmar, Wethersfield.	37.00
			W. F. Andross, E. Hartford.	37.00
			G. A. Dickinson, Haddam.	36.00
			E. L. Strong, Colchester.	34.00
			D. N. Clark & Sons, Milford.	34.00
3909	Tobacco Grower.	Bradley Fertilizer Co., Boston, Mass.	M. McNamara, New Milford.	40.00

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SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cashprice per ton.
3980	Reese's Potato Special.	J. S. Reese & Co., Baltimore.	W. H. Anderson, Putnam.	$34.00
			Donald Gunn, Groton.	38.00
3956	Vegetable, Vine, and Tobacco Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	S. C. Lewis, Stratford.	33.00
			Fred Morton, Rocky Hill.	35.00
			Lyman W. Hall, Goshen.	33 00
			Wm. Barr & Sons, Fairfield.	33.00
3870	Stockbridge Manure for Grain.	Bowker Fertilizer Co., Boston, Mass.	A. J. Payne, Danielsonville.	40 00
			J. A. Lewis, Willimantic.	40.00
			J. M. Williams, Manchester.	40.00
			City Coal & Wood Co., New Britain.	37.00
3906	Potato and Tobacco Fertilizer.	Clark's Cove Fertilizer Co, Boston, Mass.	J. M. Burke, So. Manchester.	33 00
3938	Potato and Root Crop Manure.	Darling Fertilizer Co., Pawtucket R. I.	Treat & Clark, Orange.	39.00
3957	Grass and Grain Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	B. C Bradley, South Britain.	34.00
			C. L Stearns, Andover.	30.00
			Fred. Morton, Rocky Hill.	35.00
3878	Potato Manure.	Williams & Clark Fertilizer Co., 71 Fulton St., N. Y.	Daniel Morgan, Poquonock.	34.00
			Beaumont Bros., Wallingford.	35.00
			Terrill Betts, Sandy Hook.	40.00
			N. P. Burr, Kensington.	38.00
			H. K. Brainard, Thompsonville.	35 00
			E. L. Strong, Colchester.	34.00
			L. J Grant, Wapping.	36.00
3843	High Grade Potato Fertilizer.	The E. Frank Coe Co., 16 Burling Slip, N. Y.	F. P. Burr, Middletown.	34.00
			W. C. Reynolds, Goodspeeds.	36.00
			W. A. Burr, West Hartford.	40.00
			J. W. Denison, Mystic.	35.00
3842	Potato, Hop and Tobacco Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	John Wells, Hebron.	26.00
			J. C. Lincoln, Berlin.	34.00
			H. Fish, Newington.	35.00
			J. E. Leonard, Jewett City.	35.00

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SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3953	Havana Tobacco Fertilizer.	Quinnipiac Co., 92 State St., Boston, Mass.	J. W. Gardner, Cromwell.	$48.00
3879	High Grade Special for Potatoes, Tobacco, etc.	Williams & Clark Fertilizer Co., 71 Fulton St., N. Y.	Dan. Morgan, Poquonock.	39.00
			J. G. Grant, Wapping.	40.00
			S. D. Woodruff & Sons, Orange.	37.00
			John Bransfield, Portland.	40.00
3936	Potato Manure.	Lister's Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	38.00
3905	Special Potato Manure.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	J. C. Lincoln, Berlin.	38.00
			W. H. Anderson, Putnam.	38.00
3871	Stockbridge Manure for Potatoes.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	J. A. Lewis, Willimantic.	40.00
			City Coal & Wood Co., New Britian.	37.00
			W. F. Andross, E Hartford.	40.00
			F. Hallock & Co., Birmingham.	38.00
			J. M. Williams, Manchester.	40.00
			W. H. Anderson, Putnam.	40.00
			E. B. Clark & Sons, Milford.	38.00
3886	Complete Manure for Corn & Grain	Bradley Fertilizer Co., Boston, Mass.	D. N. Clark & Sons, Milford.	39.00
			M. Beach & Son, New Milford.	40.00
3844	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston, Mass.	L. F. Judson, Stratford	38.00
			Bulkley & Tanner, Wethersfield.	40.00
			H. K. Brainard, Thompsonville.	38.00
			R. A. Parker, Warehouse Point.	38.00
3813	Potato Manure.	Bradley Fertilizer Co., Boston, Mass.	L. F. Judson, Stratford.	37.00
			Wilson & Burr, Middletown.	36.00
			A. C. Sternberg, Hartford.	35 00
			Bulkley & Hanmar, Wethersfield.	37.00
			W. F. Andross, E. Hartford.	37.00
			G. A. Dickinson, Haddam.	36.00
			E. L. Strong, Colchester.	34.00
			D. N. Clark & Sons, Milford.	34.00
3909	Tobacco Grower.	Bradley Fertilizer Co., Boston, Mass.	M. McNamara, New Milford.	40.00

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SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' cash price per ton.
3980	Reese's Potato Special.	J. S. Reese & Co., Baltimore.	W. H. Anderson, Putnam.	$34.00
			Donald Gunn, Groton.	38.00
3956	Vegetable, Vine, and Tobacco Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	S. C. Lewis, Stratford.	33.00
			Fred Morton, Rocky Hill.	35.00
			Lyman W. Hall, Goshen.	33 00
			Wm. Barr & Sons, Fairfield.	33.00
3870	Stockbridge Manure for Grain.	Bowker Fertilizer Co., Boston, Mass.	A. J. Payne, Danielsonville.	40 00
			J. A. Lewis, Willimantic.	40.00
			J. M. Williams, Manchester.	40.00
			City Coal & Wood Co., New Britain.	37.00
3906	Potato and Tobacco Fertilizer.	Clark's Cove Fertilizer Co, Boston, Mass.	J. M. Burke, So. Manchester.	33 00
3938	Potato and Root Crop Manure.	Darling Fertilizer Co., Pawtucket R. I.	Treat & Clark, Orange.	39.00
3957	Grass and Grain Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	B. C Bradley, South Britain.	34.00
			C. L Stearns, Andover.	30.00
			Fred. Morton, Rocky Hill.	35.00
3878	Potato Manure.	Williams & Clark Fertilizer Co., 71 Fulton St., N. Y.	Daniel Morgan, Poquonock.	34.00
			Beaumont Bros., Wallingford.	35.00
			Terrill Betts, Sandy Hook.	40.00
			N. P. Burr, Kensington.	38.00
			H. K. Brainard, Thompsonville.	35 00
			E. L. Strong, Colchester.	34.00
			L. J Grant, Wapping.	36.00
3843	High Grade Potato Fertilizer.	The E. Frank Coe Co., 16 Burling Slip, N. Y.	F. P. Burr, Middletown.	34.00
			W. C. Reynolds, Goodspeeds.	36.00
			W. A. Burr, West Hartford.	40.00
			J. W. Denison, Mystic.	35.00
3842	Potato, Hop and Tobacco Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	John Wells, Hebron.	26.00
			J. C. Lincoln, Berlin.	34.00
			H. Fish, Newington.	35.00
			J. E. Leonard, Jewett City.	35.00

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Analyses of Special Manures Sampled by the Station.—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.			Cost per ton.	Valuation per Ton.	Percentage difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.			
3840	Mapes' Manure for Potatoes	1.02	.75	2.21	3.98	*3.7*	6.56	2.50	.87	9.93	*8.0*	9.06	*8.0*	.74	7.55	*6.0*	$42.00	$33.49	25.4
3887	Baker's Complete Corn Manure	....	3.62	.50	4.12	*5.0*	6.72	.62	....	7.34	....	7.32	*6.3*	7.41	7.41	*7.0*	38.00	30.22	25.7
3973	Wilcox's Potato, Onion and Tobacco Manure	.58	.21	2.57	3.36	*3.3*	4.88	2.32	1.65	8.85	*8.0*	7.20	*8.0*	3.76	6.65	*6.0*	35.00	27.86	25.7
3873	Stockbridge Manure for Top Dressing	3.36	....	1.75	5.11	*5.0*	3.78	3.02	3.09	9.89	*6.0*	6.80	*3.0*	6.03	6.03	*5.0*	40.00	31.75	25.9
3953	Quinnipiac Co's Havana Tobacco Fertilizer	....	3.08	2.77	5.85	*5.8*	1.39	3 09	1.49	5.97	*6.0*	4.48	*5.0*	.81	10.80	*10.0*	48.00	38.01	26.3
3879	Williams & Clark Co's High Grade Special for Potatoes, Tobacco, etc.	.14	1.28	2.19	3.61	*3.7*	6.14	2.88	.96	9.98	*8.0*	9.02	*7.0*	7.13	7.13	*7.0*	39 00	30.71	27.0
3936	Lister Chemical Works' Potato Manure	....	2.30	1.47	3.77	*2.5*	6.02	1.51	1.13	8.66	....	7.53	*7.5*	7.48	7.48	*7.0*	38.00	29.79	27.5
3905	Crocker Special Potato Manure	....	.08	3.53	3.61	*3.7*	6.82	1.46	.36	8.64	*9.0*	8.28	*8.0*	7.02	7.02	*5.4*	38.00	29.71	27.9
3871	Stockbridge Manure for Potatoes	2.33	....	1.52	3.85	*3.3*	5.49	4.48	2.03	12.00	*8.0*	9.97	*7.0*	5.12	5.12	*5.0*	39.00	30.48	27.9
3886	Bradley's Manure for Corn and Grain	.77	trace	2.76	3.53	*3.3*	4.32	7.21	4.26	15.79	*13.0*	11.53	*12.0*	2.43	2.43	*3.0*	39.00	30.22	29.0
3844	Bradley's Manure for Potatoes and Vegetables	.79	.62	2.27	3.68	*3.7*	6 48	2,03	1.21	9.72	*9.0*	8.51	*8.0*	5.94	5.94	*6.0*	38.00	29.21	30.1
3813	Bradley's Potato Manure	.24	....	3.60	3.84	*2.5*	4.40	2.37	1.95	8.72	*8.0*	6.77	*8 0*	5.26	5.26	*5 0*	36.00	27.41	31.3
3909	Bradley's Tobacco Grower	1.75	....	1.13	2.88	*2.5*	6.88	3.42	1.02	11.32	*12.0*	10.30	*8.0*	1.57	6.78	*7.0*	40.00	29.98	33.4
3980	Reese's Potato Special	....	.70	1.83	2.53	*2.9*	4.46	3.55	.71	8.72	*7.0*	8.01	*6.0*	8.42	8.42	*7.5*	36.00	26.71	34.8
3956	Great Eastern Vegetable, Vine and Tobacco Fertilizer	.35	....	1.91	2.26	*2.0*	6.76	1.80	.59	9.15	....	8.56	*8.0*	5.87	5.87	*6.0*	33.00	24.24	36.1
3870	Stockbridge Manure for Grain	1.13	....	2.38	3.51	*3.3*	6.74	3.50	2.05	12.29	*9.0*	10.24	*8.0*	4.06	4.06	*4.2*	40.00	29.27	36.6

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ANALYSES OF SPECIAL MANURES SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.			Cost per ton.	Valuation per Ton.	Percentage difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.			
3906	Clark's Cove Potato and Tobacco Fertilizer	....	....	2.09	2.09	*2.0*	7.44	2.39	1.81	11.64	*9.0*	9.83	*8.0*	3.80	3.80	*3.0*	$33.00	$24.00	37.5
3938	Darling's Potato and Root Fertilizer	.12	.53	1.93	2.58	*3.0*	5.22	4.84	2.43	12.49	*10.0*	10.06	*6.0*	6.41	6.41	*7.0*	39.00	28.27	37.9
3957	Great Eastern Grass and Grain Fertilizer	.46	....	2.59	3.05	*2.9*	5.79	2.56	1.04	9.39	*9.0*	8.35	*8.0*	2.22	2.22	*2.0*	33.00	23.51	40.4
3878	Williams & Clark Co's Potato Manure	.12	....	2.77	2.89	*2.5*	5.57	1.94	.68	8.19	*7.0*	7.51	*6.0*	3.85	5.48	*5.0*	36.00	25.16	43.1
3843	Coe's High Grade Potato Fertilizer	....	.43	1.70	2.13	*2.0*	6.13	2.18	2.08	10 39	....	8.31	*8.0*	.49	5.16	*5.9*	35.00	24.41	43.4
3842	Crocker's Potato, Hop and Tobacco Phosphate	..	....	2.13	2.13	*0.0*	7.79	1.83	.73	10.35	....	9.62	*10.0*	4.39	4.39	*3 2*	35.00	24.03	45.7
3959	Pacific Guano Co. Special Potato Manure	.13	.07	2.55	2.75	*2.5*	5.17	2.30	.81	8.28	*7.0*	7.47	*5.0*	4.72	5.09	*5.0*	35.00	24.04	45.7
3838	Chittenden's Complete Fertilizer	....	.79	2.22	3.01	*3.3*	6.19	2.83	1.24	10.26	*10.0*	9.02	*8.0*	4.66	4.66	*6 0*	39.00	26.61	46.5
3955	Cumberland Potato Fertilizer	.26	....	1.96	2.22	*2.0*	6.88	2.68	1.79	11.35	....	9.56	*9.0*	3.65	3.65	*3.3*	35 00	23.85	46.7
3979	Quinnipiac Corn Manure	....	....	2.22	2.22	*2.0*	7.18	2.79	2.22	12.19	*10.0*	9.97	*9.0*	1.75	1.75	*1.5*	34.00	22.92	48.4
3817	Quinnipiac Potato Manure	.16	.08	2.36	2.60	*2.5*	5.26	3.34	1.16	8.76	*7.0*	7.60	*6.0*	4.90	5.35	*5.0*	36.00	24.05	49.7
3969	Williams & Clark Co's Americus Corn Phosphate	....	....	2.46	2.46	*2.0*	7.49	2.73	1.72	11.94	*13.5*	10.22	*9.0*	1.68	1.68	*1.5*	36.00	23.83	51.1
3841	Crocker's Ammoniated Wheat and Corn Phosphate	....	....	2.20	2.20	*2.0*	6.98	2.41	1.20	10.59	*11.0*	9.39	*10.0*	1.78	1.78	*1.6*	33.00	21.75	51.7
3901	Chicopee Potato Manure	....	.37	2.25	2.62	*2.9*	6.67	1.67	1.32	9.66	*9.0*	8.34	*7.0*	4.69	4.69	*5.0*	38 00	24.56	54.7
4033	Davidge's Potato Manure	....	1.76	1.08	2.84	*2.9*	7.79	.87	.44	9.10	*10.0*	8.66	*9.0*	.36	3.58	*4.0*	39.00	25.00	56.0
3958	Great Eastern Oat, Buckwheat and Seeding Down Fertilizer	....	....	1.31	1.21	*.8*	6.34	2.25	.80	9.39	*9.0*	6.59	*8.0*	3.83	3.83	*4.0*	32.00	18.95	68.7
4034	Davidge's Special Favorite	....	.70	1.02	1.72	*1.2*	4.78	2.00	1.87	8.65	*11.0*	6.78	*10.0*	.33	2.38	*1.5*	33.00	17.88	84.5

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Analyses of Special Manures Sampled by the Station.—*Continued.*

Station No.	Name or Brand.	Nitrogen,					Phosphoric Acid.							Potash.			Cost per ton.	Valuation per Ton.	Percentage difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.			
3840	Mapes' Manure for Potatoes	1.02	.75	2.21	3.98	*3.7*	6.56	2.50	.87	9.93	*8.0*	9.06	*8.0*	.74	7.55	*6.0*	$42.00	$33.49	25.4
3887	Baker's Complete Corn Manure	----	3.62	.50	4.12	*5.0*	6.72	.62	----	7.34	----	7.32	*6.3*	7.41	7.41	*7.0*	38.00	30.22	25.7
3973	Wilcox's Potato, Onion and Tobacco Manure	.58	.21	2.57	3.36	*3.3*	4.88	2.32	1.65	8.85	*8.0*	7.20	*8.0*	3.76	6.65	*6.0*	35.00	27.86	25.7
3873	Stockbridge Manure for Top Dressing	3.36	----	1.75	5.11	*5.0*	3.78	3.02	3.09	9.89	*6.0*	6.80	*3.0*	6.03	6.03	*5.0*	40.00	31.75	25.9
3953	Quinnipiac Co's Havana Tobacco Fertilizer	----	3.08	2.77	5.85	*5.8*	1.39	3 09	1.49	5.97	*6.0*	4.48	*5.0*	.81	10.80	*10.0*	48.00	38.01	26.3
3879	Williams & Clark Co's High Grade Special for Potatoes, Tobacco, etc.	.14	1.28	2.19	3.61	*3.7*	6.14	2.88	.96	9.98	*8.0*	9.02	*7.0*	7.13	7.13	*7.0*	39 00	30.71	27.0
3936	Lister Chemical Works' Potato Manure	----	2.30	1.47	3.77	*2.5*	6.02	1.51	1.13	8.66	----	7.53	*7.5*	7.48	7.48	*7.0*	38.00	29.79	27.5
3905	Crocker Special Potato Manure	----	.08	3.53	3.61	*3.7*	6.82	1.46	.36	8.64	*9.0*	8.28	*8.0*	7.02	7.02	*5.4*	38.00	29.71	27.9
3871	Stockbridge Manure for Potatoes	2.33	----	1.52	3.85	*3.3*	5.49	4.48	2.03	12.00	*8.0*	9.97	*7.0*	5.12	5.12	*5.0*	39.00	30.48	27.9
3886	Bradley's Manure for Corn and Grain	.77	trace	2.76	3.53	*3.3*	4.32	7.21	4.26	15.79	*13.0*	11.53	*12.0*	2.43	2.43	*3.0*	39.00	30.22	29.0
3844	Bradley's Manure for Potatoes and Vegetables	.79	.62	2 27	3.68	*3.7*	6 48	2,03	1.21	9.72	*9.0*	8.51	*8.0*	5.94	5.94	*6.0*	38.00	29.21	30.1
3813	Bradley's Potato Manure	.24	----	3.60	3.84	*2.5*	4.40	2.37	1.95	8.72	*8.0*	6.77	*8.0*	5.26	5.26	*5.0*	36.00	27.41	31.3
3909	Bradley's Tobacco Grower	1.75	----	1.13	2.88	*2.5*	6.88	3.42	1.02	11.32	*12.0*	10.30	*8.0*	1.57	6.78	*7.0*	40.00	29.98	33.4
3980	Reese's Potato Special	----	.70	1.83	2.53	*2.9*	4.46	3.55	.71	8.72	*7.0*	8.01	*6.0*	8.42	8.42	*7.5*	36.00	26.71	34.8
3956	Great Eastern Vegetable, Vine and Tobacco Fertilizer	.35	----	1.91	2.26	*2.0*	6.76	1.80	.59	9.15	----	8.56	*8.0*	5.87	5.87	*6.0*	33.00	24.24	36.1
3870	Stockbridge Manure for Grain	1.13	----	2.38	3.51	*3.3*	6.74	3.50	2.05	12.29	*9.0*	10.24	*8.0*	4.06	4.06	*4.2*	40.00	29.27	36.6

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Analyses of Special Manures Sampled by the Station.—*Continued.*

Station No.	Name or Brand.	Nitrogen.					Phosphoric Acid.							Potash.			Cost per ton.	Valuation per Ton.	Percentage difference between Cost and Valuation.
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.			
3906	Clark's Cove Potato and Tobacco Fertilizer	....	....	2.09	2.09	*2.0*	7.44	2.39	1.81	11.64	*9.0*	9.83	*8.0*	3.80	3.80	*3.0*	$33.00	$24.00	37.5
3938	Darling's Potato and Root Fertilizer	.12	.53	1.93	2.58	*3.0*	5.22	4.84	2.43	12.49	*10.0*	10.06	*6.0*	6.41	6.41	*7.0*	39.00	28.27	37.9
3957	Great Eastern Grass and Grain Fertilizer	.46	....	2.59	3.05	*2.9*	5.79	2.56	1.04	9.39	*9.0*	8.35	*8.0*	2.22	2.22	*2.0*	33.00	23.51	40.4
3878	Williams & Clark Co's Potato Manure	.12	....	2.77	2.89	*2.5*	5.57	1.94	.68	8.19	*7.0*	7.51	*6.0*	3.85	5.48	*5.0*	36.00	25.16	43.1
3843	Coe's High Grade Potato Fertilizer	....	.43	1.70	2.13	*2.0*	6.13	2.18	2.08	10 39	....	8.31	*8.0*	.49	5.16	*5.9*	35.00	24.41	43.4
3842	Crocker's Potato, Hop and Tobacco Phosphate	..	....	2.13	2.13	*0.0*	7.79	1.83	.73	10.35	....	9.62	*10.0*	4.39	4.39	*3 2*	35.00	24.03	45.7
3959	Pacific Guano Co. Special Potato Manure	.13	.07	2.55	2.75	*2.5*	5.17	2.30	.81	8.28	*7.0*	7.47	*5.0*	4.72	5.09	*5.0*	35.00	24.04	45.7
3838	Chittenden's Complete Fertilizer	....	.79	2.22	3.01	*3.3*	6.19	2.83	1.24	10.26	*10.0*	9.02	*8.0*	4.66	4.66	*6 0*	39.00	26.61	46.5
3955	Cumberland Potato Fertilizer	.26	....	1.96	2.22	*2.0*	6.88	2.68	1.79	11.35	....	9.56	*9.0*	3.65	3.65	*3.3*	35.00	23.85	46.7
3979	Quinnipiac Corn Manure	....	....	2.22	2.22	*2.0*	7.18	2.79	2.22	12.19	*10.0*	9.97	*9.0*	1.75	1.75	*1.5*	34.00	22.92	48.4
3817	Quinnipiac Potato Manure	.16	.08	2.36	2.60	*2.5*	5.26	3.34	1.16	8.76	*7.0*	7.60	*6.0*	4.90	5.35	*5.0*	36.00	24.05	49.7
3969	Williams & Clark Co's Americus Corn Phosphate	....	....	2.46	2.46	*2.0*	7.49	2.73	1.72	11.94	*13.5*	10.22	*9.0*	1.68	1.68	*1.5*	36.00	23.83	51.1
3841	Crocker's Ammoniated Wheat and Corn Phosphate	....	....	2.20	2.20	*2.0*	6.98	2.41	1.20	10.59	*11.0*	9.39	*10.0*	1.78	1.78	*1.6*	33.00	21.75	51.7
3901	Chicopee Potato Manure	....	.37	2.25	2.62	*2.9*	6.67	1.67	1.32	9.66	*9.0*	8.34	*7.0*	4.69	4.69	*5.0*	38 00	24.56	54.7
4033	Davidge's Potato Manure	....	1.76	1.08	2.84	*2.9*	7.79	.87	.44	9.10	*10.0*	8.66	*9.0*	.36	3.58	*4.0*	39.00	25.00	56.0
3958	Great Eastern Oat, Buckwheat and Seeding Down Fertilizer	....	....	1.21	1.21	*.8*	6.34	2.25	.80	9.39	*9.0*	6.59	*8.0*	3.83	3.83	*4.0*	32.00	18.95	68.7
4034	Davidge's Special Favorite	....	.70	1.02	1.72	*1.2*	4.78	2.00	1.87	8.65	*11.0*	6.78	*10.0*	.33	2.38	*1.5*	33.00	17.88	84.5

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3930. Mapes' Tobacco Manure, Wrapper brand. On account of a protest from the manufacturer to the effect that the per cent. of nitrogen found was abnormally low, another sample was drawn and analyzed. This is No. **3995,** given on page 49, and here reproduced for comparison. It contains .8 per cent. more nitrogen than the first analysis.

3962. Market Garden Manure, made by the Quinnipiac Co. of Boston. The manufacturer objects to this analysis because both nitrogen and potash are below the minimum guarantee and below the average quality of the goods. An attempt to find other samples of the brand after the protest was received proved unsuccessful.

4005. Fairchild's Formula for Corn and General Crops, made by the Rogers & Hubbard Co., Middletown. A protest was made by the manufacturer against this analysis on account of the deficiency of both potash and phosphoric acid.

ANALYSES.

	3892	3951	3910	3930	3995	3962	4005
Nitrogen as nitrates	....	....	....	1.23	1.27	.12	4.92
as ammonia	3.76	3 92	3.06	2.42	2.50	.78	....
organic	1.01	.47	.66	1.96	2 67	2.36	1.45
Total nitrogen found	4.77	4 40	3.72	5.61	6 44	3.26	6.37
guaranteed	4.5	4.5	....	6.2	6.2	3.3	5.5
Soluble phosphoric acid	4.61	3.58	4.83	.37	....	5.26	....
Reverted phosphoric acid	1.06	1.02	1.10	3.74	3.43	3.81	....
Insoluble phosphoric acid	.56	.68	.66	2.09	1.96	1.47	....
Total phosphoric acid found	6.23	5.28	6.59	6.20	5.39	10.54	11.49
guaranteed	....	....	....	4.5	4.5	9.0	12.0
Potash as muriate	.82	.81	7.45	.61	.27	6 63	11.61
Total potash found	9.51	11.70	11.71	11.57	11.87	6.63	11.61
guaranteed	10.0	10.0	....	10.5	10.5	7.0	12.5

GUARANTEES.

Of the fifty brands of Special Manures analyzed, thirteen are quite below the manufacturer's minimum guarantee in respect of one ingredient, and nine are below in respect of two ingredients.

COST, VALUATION, AND PERCENTAGE DIFFERENCE.

The average cost per ton of the Special Manures has been $37.76. The average valuation, $29.35, and the percentage difference 28.6 per cent. Last year the corresponding figures were, average cost, $38.28, average valuation, $30.70, percentage difference, 25.0 per cent.

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2. *Sampled by Manufacturers, and* 3. *Sampled by Private Individuals.*

2. *Manufacturers' Samples.*

These samples were sent to the Station in compliance with the terms of the Fertilizer Law and were analyzed because no samples of the brands named were found in market by our sampling agents.

3998. Complete Manure for Top Dressing Grass and Grain. Made by the Bradley Fertilizer Co., Boston, Mass.

3985. Special Connecticut Tobacco Manure. Made by Crocker Fertilizer and Chemical Co., Buffalo, N. Y.

3988. Darling's Tobacco Grower. Made by the L. B. Darling Fertilizer Co., Providence, R. I.

4002. Special Tobacco Manure. Made by Walker, Stratman & Co., Pittsburg, Pa.

4003. Potato Special Fertilizer. Made by Walker, Stratman & Co.

3. *Samples drawn by Private Individuals.*

4013. Chittenden's Complete Fertilizer for Tobacco. Made by the National Fertilizer Co., Bridgeport. Sampled by T. J. Stroud, Shaker Station.

3751. Potato Fertilizer. Made by Preston Fertilizer Co., Greenpoint, N. Y. Sampled by John Mick, Westport.

3752. Onion Fertilizer. Made by Preston Fertilizer Co. Sampled by John Mick, Westport.

4012. Mixed Formula for Top Dressing. Made by L. Sanderson, New Haven. Sampled by W. S. Clark, Stephenson.

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Analyses and Valuations.

	3998	3985	3988	4002	4003	4013	3751	3752	4012
Nitrogen as nitrates	5.66	.86	....	....	....	....	....	....	.29
as ammonia	....	.16	.20	.11	....	2.13	3.23	3.91	....
organic	....	5.99	4.34	1.68	1.56	3.00	.47	.27	.75
Total nitrogen found	5.66	7.01	4.54	1.79	1.56	5.13	3.70	4.18	1.04
Nitrogen guaranteed	....	5.75	....	2.4	2.4	3.3	3.3	3.5	4.0
Soluble phosphoric acid	.32	6.66	2.69	5.09	4.80	9.60	7.54	7.70	11.95
Reverted	5.01	1.06	3.07	1.81	1.94	1.27	.72	.89	.73
Insoluble	1.94	.25	1.85	5.61	5.95	.39	.18	.10	.39
Total phosphoric acid found	7.29	7.97	7.61	12.51	12.69	11.26	8.44	8.69	13.07
Phosphoric acid guaranteed	....	....	....	10.0	12.0	10.0	....	....	....
Available phosphoric acid found	5.33	7.72	5.76	6.90	6.74	10.87	8.26	8.59	12.68
Available phosphoric acid guaranteed	....	5.0	....	8.0	10.0	8.0	8.0	7.0	7.0
Potash	2.94	9.41	10.95	3.87	6.96	7.97	7.74	7.65	8.93
Potash guaranteed	....	10.0	....	6.0	10.0	10.0	7.0	7.0	7.0
Valuation per ton	$27.92	44.46	34.65	20.76	22.67	40.62	30.79	32.24	29.13

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IV. Home Mixtures.

Here are included fertilizers which have been home-made from chemicals or raw materials bought of wholesale dealers. This method of preparing mixed fertilizers is steadily growing in favor, particularly with those who study most closely the special requirement of their particular soils and crops. The formulas by which the mixtures are made are first given, followed by the analyses.

3819. Potato Fertilizer, made by D. Fenn, Milford.

Formula.

1000	pounds	Blood, Bone and Meat.
600	"	Dissolved Bone Black.
200	"	Muriate of Potash.
200	"	Nitrate of Soda.
2000	"	

Cost of materials $36.05 per ton, delivered.

4007. For General Use, made by N. D. Platt, Milford.

2000	pounds	Blood, Bone and Meat.
2000	"	Dissolved Bone Black.
500	"	Muriate of Potash.
500	"	Sulphate of Potash.
300	"	Sulphate of Ammonia.
200	"	Nitrate of Soda.
500	"	Ground Bone.
6000	"	

Cost of materials $35.96 per ton, delivered.

4008. For Corn, made by Dennis Fenn, Milford.

600	pounds	Bone Black.
600	"	Blood, Bone and Meat.
200	"	Nitrate of Soda.
250	"	Ground Bone.
150	"	Muriate of Potash.
1800	"	

Cost of materials $35.60 per ton, delivered.

4009. For Potatoes, made by Waldo Miller, Middlefield.

800	pounds	Tankage.
800	"	Acid Phosphate.
400	"	Muriate of Potash.
2000	"	

Cost not given.

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4010. For Potatoes, made by G. F. Platt, Milford.

800	pounds	Blood, Bone and Meat.
400	"	Ground Bone.
550	"	Dissolved Bone Black.
50	"	Sulphate of Ammonia.
100	"	Nitrate of Soda.
50	"	Sulphate of Potash.
50	"	Muriate of Potash.
2000	"	

Cost of materials $35.31 per ton, delivered.

In the following table is given the actual cost of the ingredients, at *regular retail cash rates*, delivered at the purchasers' freight station. If to this is added $2.00 per ton as the cost of mixing on the farm we find the average cost of the four fertilizers to be $37.74 per ton and the average valuation $33.30. The percentage difference between cost and valuation is 6.8. That is, the valuation is very much nearer the cost price than it is in most factory-mixed goods.

HOME-MIXED FERTILIZERS.—ANALYSES AND VALUATIONS.

Station No.,	3819	4007	4008	4009	4010
Nitrogen as nitrates	1.89	.46	1.61	....	.60
as ammonia	....	1.14	....	....	.49
organic	3.47	2.62	3.18	2.87	3.87
Total nitrogen	5.36	4.22	4.80	2.87	4.96
Soluble phosphoric acid	3.92	6.40	6.08	5.75	4.48
Reverted phosphoric acid	4.55	3.11	2.76	2.27	4.10
Insoluble phosphoric acid	2.21	1.95	2.78	1.34	5.04
Total phosphoric acid	10.68	11.46	11.64	9.36	13.62
Potash as muriate	5.37	6.40	5.61	9.30	1.32
Total potash	5.37	7.23	5.61	9.30	2.07
Cost per ton	$36.05	35.96	35.60	....	35.31
Valuation per ton	$34.07	33.76	33.53	29.16	31.86

COTTON HULL ASHES.

In the following table are given 28 analyses of this material which were made on samples sent to the Station during the present year. They show the usual differences in quality, the per cent. of potash soluble in water ranging from 15.30 to 27.40. The average per cent. is 21.91.

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Analyses of Cotton Hull Ashes.

Station No.	Dealer or Purchaser.	Sampled by	Soluble Phosphoric Acid.	"Reverted" Phosphoric Acid.	Insoluble Phosphoric Acid.	Potash Soluble in Water.	Cost per ton.	Valuation per ton.	Potash, costs Per pound In cents.
3735	G. H. & J. H. Hale, South Glastonbury	J. H. Hale	.83	7.86	1.20	19.77	$17.00*	$32.73	1.5
4018	Olds & Whipple, Hartford	Station Agent	3.09	6.65	2.30	27.44	40.00	43.10	4.9
3784	Geo. Douglass, Suffield	Luke F. Woodworth, Thompsonville	.83	5.88	1.75	26.21	35.00	37.67	5.0
3846	Olds & Whipple, Hartford	John Giligan, Windsor	1.50	5.79	2.92	24.90	40.00	37.46	6.0
3773	I. Luther Spencer, Suffield	E. S. Seymour, Windsor Locks	1.58	7.63	2.56	23.34	40.00	37.90	6.0
3868	I. Luther Spencer, Suffield	O. W. Kellogg	1.50	7.01	2.66	23.68	40.00	37.47	6.0
4017	Olds & Whipple, Hartford	Station Agent	.82	6.50	1.69	25.20	40.00	37.27	6.0
3741	Olds & Whipple, Hartford	L. L. Bedortha, Windsor	.32	8.23	1.07	24.15	40.00	37.30	6.1
3788	Olds & Whipple, Hartford	Station Agent	.45	8.51	.94	23.32	40.00	36.83	6.2
3792	T. Soule & Co., New Milford	T. Soule & Co., New Milford	.66	6.18	.99	24.66	40.00	35.81	6.4
3825	Olds & Whipple, Hartford	John DuBon, Poquonock	trace	6.31	1.56	22.76	39.00	33.86	6.6
4016	Olds & Whipple, Hartford	Station Agent	.64	4.48	.85	24.21	40.00	33.18	6.9
3863	W. W. Cooper, Suffield	Robert Obram	.48	5.16	2.64	25.18	43.00	35.57	7.0
3981	Olds & Whipple, Hartford	†F. H. Whipple	.62	6.69	.69	24.96	45.00	36.58	7.2
3847	A. H. Rice, Granby	H. A. Sheldon, West Suffield	.56	5.66	2.22	19.13	36.00	29.45	7.2
3866	Edward Austin, Suffield	Dexter F. Remington, Suffield	.78	7.41	2.66	24.24	48.00	37.63	7.6
4063	Olds & Whipple, Hartford, stock sold to Messrs. Lamphear, Alvord & Clark, Poquonock	Station Agent	.19	3.46	1.52	23.15	41.00	30.48	7.8
3810	R. A. Parker, Warehouse Point	G. S. Phelps, Warehouse Point	.96	4.96	1.70	22.42	43.00	32.54	7.8
3864	Olds & Whipple, Hartford	Chas. M. Owen, Suffield	.62	5.86	2.42	19.64	40.00	30.41	7.9
3849	Olds & Whipple, Hartford	Louis Clapp	none	5.30	2.55	20.40	40.00	29.82	8.0
3789	Olds & Whipple, Hartford	Station Agent	trace	5.75	1.47	19.87	40.00	29.35	8.1
3923	Olds & Whipple, Hartford	Station Agent	.83	6.35	2.03	17.45	39.00	28.71	8.4
3982	W. F. Fletcher, Southwick, Mass.	A. H. Griffin, Granby	.21	5.19	2 53	22.04	47.00	31.75	9.0
3922‡	Edward Austin, Suffield	‡ E. G. Hastings, Silas L. Wood, and Wm. H. Lillie, West Suffield	.56	6.29	2.00	19.78	48.00	30.84	9.8
3865	Edward Austin, Suffield	Dexter F. Remington, Suffield	.40	5.94	2.85	17.60	48.00	28.15	11.1
3867	E. S. Hough, Poquonock	Eugene Brown, Poquonock	.46	3.78	1.30	15.30	40.00	22.49	11.2
3897	E. S. Hough, Poquonock	W. H. Harvey, Windsor	trace	2.75	1.60	15.84	40.00	21.36	11.4
3850	F. W. Brodie & Co., Memphis, Tenn.	S. O. Griswold, Poquonock	....	....	....	16.78	....	....	....

* In car lots. † In presence of P. P. Hickey, Burnside. ‡ Mixture of three samples.

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The cost of potash per pound at retail in cotton-hull ashes has ranged from 4.9 to 11.4 cents per pound and has averaged 6.9 cents. Cotton-hull ash has ceased to be a cheap source of potash.

On the average, potash has cost, this year, over a cent per pound more in this form than in high grade sulphate. It is, however, a favorite fertilizer with many tobacco growers and is chiefly used on the tobacco crop.

Spurious Cotton Hull Ashes.

On March 17, the Station reported Analysis No. **3753** made on a sample drawn by A. E. Holcomb, Poquonock, from stock purchased of Olds & Whipple, Hartford.

On March 23, analysis No. **3780** was reported. The sample was drawn by H. C. Griswold, Poquonock, from stock purchased by him out of the same car as Mr. Holcomb's stock.

In order that there might be no possible question as to the sampling, the Station, at the request of Messrs. Olds & Whipple sent an agent to Windsor who drew samples from five different lots of ashes that came from the same car as the samples just mentioned which had been bought by Clark Brothers, H. C. Griswold, M. Larney, F. G. Strickland and A. E. Holcomb. A mixture was prepared of equal parts of these samples, making the Station sample, No. **3785**, whose composition is given below.

Analyses of Spurious Cotton Hull Ashes.

	3753	3780	3785
Potash	9.85†	7.21*	10.06
Soda	1.38	....	1.84
Lime	32.79	31.97	32.14
Magnesia	3.63	4.74	3.17
Oxide of iron and alumina	5.76	6.03	6.15
Phosphoric acid	1.54	....	1.30
Sulphuric acid	....	....	1.61
Carbonic acid	18.66	20.01	19.58
Sand and silica	23.45	23.59	22.58
Water, free and combined	1.89	....	1.51
	98.95		99.94
"Valuation"	$9.08	....	$8.59

These "Cotton Hull Ashes" were possibly from a heap that had been partially leached by rain and mixed with sand, earth, or coal ashes.

* Soluble in water. † Soluble in acid.

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The dealers, Messrs. Olds & Whipple, as soon as they were made aware of the character of the goods, immediately recalled them, settled with those who had bought them and returned the car to the south.

How difficult it is to judge of the quality of cotton hull ashes by simple inspection is shown by the analyses of the following samples.

4014. "This sample is drawn from one of four bags we found in a four-ton lot. I am curious to know if these are what they purport to be or if they are only 'boiler cleanings.' We have set them aside as almost worthless."

The analysis given below shows that they were exceptionally good, containing over 28 per cent. of water-soluble potash.

4015. "This is from one bag of four in the same lot as the above. The color is quite dark brown."

The analysis shows that our correspondent's suspicions were well founded in this case, for these ashes were of very inferior quality.

	4014	4015
Potash soluble in water	28.49	9.30
Soluble phosphoric acid	.19	.32
Reverted phosphoric acid	5.42	2.40
Insoluble phosphoric acid	.42	.32
Cost per ton	$39.00	39.00
Valuation per ton	38.27	13.66

Unleached Wood Ashes.

3787. "Common House Ashes from my own stove." Sent by J. B. Cannon, West Suffield.

3772. From Monroe, Deforest & Co., Oswego, N. Y. A small sample sent by the manufacturer.

3778. Sold by Monroe, Deforest & Co., Oswego, N. Y. Sample of a car lot, sent by S. O. Griswold, Poquonock.

4051. Sold by Monroe, Deforest & Co., Oswego, N. Y. Sampled and sent by Herbert Barnes, New Haven.

3779. Sold by Allison, Stroup & Co., New York. Sampled and sent by J. E. Mansfield, North Haven.

3783. Sold by Allison, Stroup & Co., New York. Sampled and sent by A. P. Wakeman, Fairfield.

3855. Sold by Allison, Stroup & Co., New York. Sampled and sent by D. W. Patton, Clintonville.

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3732. Sold by F. R. Lalor, Dunville, Ontario. Sampled and sent by Stephen Smith, Montowese.

3733. Sold by F. R. Lalor, Dunville, Ontario. Sampled and sent by A. P. Wakeman, Fairfield.

3786. Sold by F. R. Lalor, Dunville, Ontario. Sampled and sent by J. B. Cannon, West Suffield.

3811. Sold by F. R. Lalor, Dunville, Ontario. Sampled and sent by S. A. Smith, Clintonville.

4053. Sold by F. R. Lalor, Dunville, Ontario. Sampled and sent by Julius Moss, West Cheshire.

3859. Sold by Chas. Stevens, Napanee, Ontario. Sampled and sent by O. E. Pitcher, Enfield Bridge.

3796. Sampled and sent by T. D. Barclay, Kent.

3857. Sold by E. N. Phelps, Windsor. Sampled and sent by Eugene Brown, Windsor.

3898. Sold by parties in London, Canada. Sampled and sent by C. A. Corey, Suffield.

4065. Sold by W. F. Fyfe & Co., Clinton, Mass. Sampled and sent by S. D. Woodruff & Sons, Orange.

4066 and **4067.** Domestic Wood Ashes. Sampled and sent by S. D. Woodruff & Sons, Orange.

These analyses show the varying quality of Canada Ashes. Two of the samples, **3811** and **3898**, were very wet, which helps explain the low percentage of potash.

For analyses see the next page.

Blood Albumin.

3730. A sample of this material, which is used in dyeing processes, sent to the Station from the farm of C. M. Beach, West Hartford, contained

Nitrogen	4.25
Phosphoric acid	.09
Potash	.16

Waste Peaches.

A sample of immature peaches was sent to the Station by the Conn. Valley Orchard Co. on the 18th of July, with the following explanation:

"I send you a sample of our peaches which we are now picking from our trees, for the sake of thinning the crop and because the peaches themselves are imperfect, largely as the result of the work of the curculio. I desire to know the likelihood of the

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ANALYSES.

	3787	3772	3778	4051	3779	3783	3855	3732	3733	3786	3811	4053	3859	3796	3857	3895	4065	4066	4067
otash soluble in water	7.03	4.06	5.61	4.85	6.69	4.64	5.39	3.38	4.85	5.42	2.81	3.51	7.19	4.85	6.16	4.63	3.35	2.93	6.41
hosphoric acid	4.86	....	1.06	1.09	1.18	.78	1.19	.91	1.57	1.45	2.88	1.28	1.47	1.36	1.41	1.14	1.37	1.79	2.11
loisture.....	....	....	14.10	....	....	....	....	....	....	....	24.72	....	....	....	....	26.70	....	....	....
ost per ton...	....	...	$11.50	11.50	....	11.40	11.50	11.00	10.00*	12.50	11.00	11.50	13.00	11.00	11.00	11.00	....	....	....

* Car lot.

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danger arising from these, if dropped on the ground under the trees, from insect life, which would come from them; I also desire to know their manurial value if they are put in heaps and allowed to decay. This will at the same time show how much they are drawing from the ground."

To allow curculio-infected fruit to drop and remain on the ground under the trees is the most effective method of securing their presence in the orchard the coming season. Soon after the fruit has fallen the grub or worm crawls out of it into the ground, pupates and comes out as a fully developed beetle either the same season or early the next. All such fruit should be removed from the orchards and so treated as to insure the destruction of the grubs or the pupæ. Probably if they are buried deeply enough the insects will be destroyed.

In one ton (of 2000 pounds) of this immature fruit there are,

Potash	7.3	lbs.
Soda	.16	"
Lime	.56	"
Magnesia	.59	"
Oxide of iron and alumina	.16	"
Phosphoric acid	1.80	"
Sulphuric acid	.38	"
Chlorine	.20	"
Sand and silica	.47	"
Nitrogen	6.40	"

It appears that a ton of this fruit contains about as much nitrogen and potash as 200 pounds of a nitrogenous superphosphate of average quality, but much less phosphoric acid. The best economy will consist in the certain destruction of all curculio in the fruit even if it is not available afterwards as a fertilizer.

Peat Moss and Swamp Muck.

3731. Peat Moss. An imported article, used as bedding and absorbent in city stables. It is much more efficient than straw for the latter purpose, besides acting as a deodorizer. It comes in bales of from 300 to 500 pounds weight. Sent from farm of C. M. Beach, West Hartford.

3791. Swamp Muck. Sent by Mrs. E. M. Lea, Plantsville.

4037. Swamp Muck. Sent by C. A. Satterlee, Gales Ferry.

This material consists chiefly of sand with just sufficient vegetable mold to give it a dark color.

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ANALYSES.

	Fresh substance.			Water-free substance.		
	3731	3791	4037	3731	3791	4037
Moisture	25.47	9.70	43.75	....	....	....
Organic and volatile matter	73.54	88.55	7.22	98.63	98.02	12.85
Ash	.99	1.75	49.03	1.37	1.98	87.15
	100.00	100.00	100.00	100.00	100.00	100.00
Nitrogen	.65	1.34	.30	.87	1.48	.53
Phosphoric acid	.25	....	.08	.34	....	.14
Potash	.13	....	.15	.17	...	.24
Sand and silica	.36	....	46.84	.48	....	81.59

The nitrogen of the peat moss is of very little if any immediate agricultural value.

"SALTPETER WASTE."

This material, sent to the Station by T. J. Stroud, Shaker Station, is a waste from the powder factory at Enfield.

The analysis, **4039,** showed such a high per cent. of nitrogen and potash that it was suggested to Mr. Stroud that it would be wise to have another sample drawn with the greatest care, as it was hard to believe that a product having this composition would be sold at the price quoted. The second analysis, however, confirms the first.

ANALYSES.

	4039	4056
Potash soluble in water	37.35	34.64
Nitrogen as nitrates	4.14	5.25
Chlorine	3.47	....

The composition of the salt is about the following:

Moisture and combined water	11.89
Sand and insoluble matters	1.86
Nitrate of potash	30.33
Sulphate of potash	42.66
Sulphates and chlorides of soda, lime and magnesia	13.26
	100.00

If the actual potash and the nitrogen are valued as in commercial fertilizers, the valuation of this material per ton will be $53.90. It is offered by the manufacturers at $25.00 per ton.

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Curd from Buttermilk.

A sample of the curd which separates from buttermilk on standing, was sent by T. M. Totman of Putnam Landing to ascertain its value as a fertilizer.

The quantity sent, stated to be the yield from one gallon of buttermilk, weighed just one pound, and contained more than 70 per cent of water.

Its value as a fertilizer consists wholly in nitrogen, of which it contained in the fresh state 3.3 per cent., that is, as much as the average superphosphate.

If a gallon of buttermilk contains a pound of curd, every 100 gallons of buttermilk will contain 3.3 pounds of nitrogen which, at the current prices of nitrogenous matters, might be reckoned as worth about 57 cents.

But it would be more economical to feed the buttermilk or the curd from it to pigs, or mixed with other feed in moderate quantity to cows.

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REVIEW OF THE FERTILIZER MARKET.

For the Ten Months ending November 1st, 1893.

Nitrogen.

Nitric Nitrogen.

The *wholesale* New York quotation of nitrogen in nitrate of soda was 13.8 cents per pound in January last. The short stock of nitrate in dealers' hands and the slow winter voyages of freighters from South America, together with the usual increased spring demand, drove the quotation up to 14.7 cents in March. It fell then to 13 cents in May and 11 cents in June. Since then it has risen considerably: to 11.4 cents in August, 11.6 cents in September, and 11.9 in October. The average wholesale quotation for the ten months has been 12.7 cents per pound. For the years 1892, 1891 and 1890 it was 12.1 cents, 12.9 cents and 11.5 cents respectively.

The *retail* ton price of nitrogen in nitrate of soda, in this State during the last season has been about 17.4 cents per pound.

Ammonic Nitrogen.

The quotations of sulphate of ammonia have fluctuated considerably during the year, and have ruled high. There is no immediate prospect of its being obtainable at as low rates as have prevailed during past years. The reasons for this are to be found in the increased demand for ammonia for ice machines and manufacturing processes, as well as in the diminished production of sulphate of ammonia owing to the increased use of water gas and the electric light. It is obtained chiefly as a by-product in the production of illuminating gas.

The *wholesale* price in New York of nitrogen in the form of sulphate of ammonia was 14 cents per pound, in January last. It rose to 17.1 cents in April and May, fell again in July to 14.9, and since then has been rising considerably; being quoted at 15.6 cents in August, 15.9 in September, and 16.4 in October. The average wholesale quotation for the ten months has been 15.7 cents per pound. The average for the years 1892, 1891 and 1890 has been 14.5, 15.6 and 16 cents respectively.

The *retail* price of nitrogen in sulphate of ammonia in Connecticut has been between 18 and 19 cents per pound for the whole season.

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Organic Nitrogen.

The wholesale quotations of nitrogen in organic form have been subject to great fluctuations during the year and have reached higher figures than for some years previously. The causes are the larger home consumption, and the extreme scarcity of raw materials. The menhaden fishery this year has been, for the most part, a failure. The high prices of corn last year have had their effect on the number of hogs butchered, and this in turn has greatly diminished the output of tankage from the slaughtering establishments. The short cotton crop last year also diminished the quantity of meal available for fertilizing purposes. It was estimated last spring that the supply of ammoniates had been reduced 50 per cent. A remarkable feature of the market was, that 2500 tons of nitrogenous matters were imported into this country within two or three months, whereas in other years there has been a considerable export trade. Among these materials has been ground offal from European slaughters, also an article called whale meat meal, claimed to consist of the flesh of whales finely ground. There was also imported a good deal of "tankage" and "animal matter" which looked and reacted remarkably like ground leather scrap and pulverized wool.

The *wholesale* New York quotation of nitrogen in red blood, low grade blood, azotin, and concentrated tankage, for each month of the year is given in detail on page 71. The quotations of blood in February and March of this year are higher than at any time previous for ten years. The quotations of these various nitrogenous matters, which had begun to rise already in June or July of 1892, rose even more rapidly during the first months of 1893 and in March last reached the highest figure of the year; the nitrogen of red blood being then quoted at 20 cents per pound, that of low grade blood at 19.8 cents, of azotin at 19.6 cents, and of concentrated tankage at 19.3 cents. Since then prices have fallen steadily till September, but quotations have risen again sharply since October 1. The quotations of dry fish have fluctuated during the last ten months between $24.00 and $30.00.

Dried blood, azotin, and concentrated tankage do not figure at all in our retail market, and no retail quotations can be given. Those who compound their own fertilizers chiefly use as a source of nitrogen either bone or a low grade of tankage which differs little in composition from bone. Neither bone nor this low grade

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tankage advanced greatly in price, when concentrated nitrogenous matters advanced sharply. There are also used, chiefly by tobacco growers, both cotton seed meal and castor pomace. Nitrogen in both these sources has been very expensive this year. As is seen by reference to page 20 the nitrogen of decorticated meal has cost at retail from 14.9 cents to 19 cents per pound, as against 14 to 16.3 cents last year. The nitrogen of castor pomace as is shown on page 21 has cost from 19.2 cents to 25.4 cents per pound. The high cost of nitrogen in cotton seed meal is due to the increased cost of the article which we understand is being shipped abroad in large quantity as a cattle food, while the still higher cost of nitrogen in castor pomace is due to the inferior quality of the article itself.

Phosphatic Materials.

Bone black and rough bone have been quoted throughout the last ten months at $19.50 per ton. Ground bone has been quoted during the same period at $22.25 per ton. Bone meal quoted in January last at $22.75 per ton, rose to $24.50 in April and May, and since then has fallen to $23.75. Ground Charleston rock, quoted in January last at $8.75 per ton, fell in February to $8.37½, at which figure it has ever since been quoted. Sulphuric acid of 66 degrees quoted in January last at 111.25, has since fallen to 106 in May, 101.25 in September, and 100 in October. Acid phosphate, 14 per cent. available, quoted in January last at 66¾, fell in February to 61¼, at which figure it has been quoted ever since. This latter quotation is equivalent to 3.09 cents per pound for available phosphoric acid at wholesale. It thus appears that phosphates have remained tolerably steady during the year, with a slight downward tendency. The retail price in Connecticut of available phosphoric acid in dissolved bone black has been from 7.5 to 8.0 cents per pound. Acid phosphate made from Charleston rock, though much cheaper, does not come into our market.

Potash.

Muriate of Potash.

The wholesale price of actual potash in this form has advanced from 3.51 cents per pound in January to 3.56 in February, and 3.75 in June, at which figure it has been quoted ever since. It has been retailed in Connecticut during the year for about 4½ cents per pound.

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Double Sulphate of Potash and Magnesia.

The wholesale quotation of potash in this form has fluctuated during the ten months between 4.25 cents and 4.32 cents per pound. It has retailed in Connecticut at about 5.8 cents per pound.

High Grade Sulphate of Potash.

The wholesale quotation of potash in this form, which was 4.7 cents per pound in January, has remained quite steady since that time at 4.16 cents. It has been sold at retail in Connecticut during the last year at prices ranging from 5.13 to 6.6 cents per pound.

Kainit.

The New York wholesale quotation of this article which opened in January at $9.17\frac{1}{2}$ per ton, has been quite steady ever since at $9.12\frac{1}{2}$.

The market quotations given above are taken from the "Oil, Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage and some other articles are quoted and sold by the ton. The seller usually has an analysis of his stock and purchasers often control this by an analysis at the time of purchase.

Sulphate of ammonia, nitrate of soda and muriate of potash are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and ammonite are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the percentage of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain $8\frac{1}{2}$ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.25 = \$19.13$.

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The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given :

Ammonia at	$3.00	per unit	is equivalent to nitrogen at		18.2	cts. per lb.
"	2.90	"	"	"	17.6	"
"	2.80	"	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"	"	"	15.8	"
"	2.50	"	"	"	15.2	"
"	2.40	"	"	"	14.6	"
"	2.30	"	"	"	14.0	"
"	2.20	"	"	"	13.4	"
"	2.10	"	"	"	12.8	"
"	2.00	"	"	"	12.2	"
"	1.90	"	"	"	11.6	"
"	1.80	"	"	"	11.0	"

Commercial sulphate of ammonia contains on an average 20.5 per cent. of nitrogen, though it varies considerably in quality. With that per cent. of nitrogen (equivalent to 24.3 per cent. of ammonia),

At 4	cents per pound.	Nitrogen costs		19.5	cents per lb.
" 3⅞	"	"	"	18.9	"
" 3¾	"	"	"	18.3	"
" 3⅝	"	"	"	17.6	"
" 3½	"	"	"	17.0	"
" 3⅜	"	"	"	16.4	"
" 3¼	"	"	"	15.8	"
" 3⅛	"	"	"	15.2	"
" 3	"	"	"	14.6	"
" 2⅞	"	"	"	14.0	"
" 2¾	"	"	"	13.4	"

Commercial Nitrate of Soda averages 95 per cent. of pure salt or 16.0 per cent. of nitrogen.

If quoted at	3.0	cents per pound,	Nitrogen costs	18.8	cents per lb.
"	2.9	"	"	18.2	"
"	2.8	"	"	17.5	"
"	2.7	"	"	16.9	"
"	2.6	"	"	16.2	"
"	2.5	"	"	15.6	"

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If quoted at	2.4	cents per pound,	Nitrogen costs	15.0	cents per lb.
"	2.3	"	"	14.4	"
"	2.2	"	"	13.8	"
"	2.1	"	"	13.2	"
"	2.0	"	"	12.5	"
"	1.9	"	"	11.9	"
"	1.8	"	"	11.3	"
"	1.7	"	"	10.6	"

Commercial Muriate of Potash and also High Grade, 98 per cent., Sulphate of Potash usually contain 50½ per cent. of actual potash.

If quoted at	2.60	cents per lb.	Actual potash costs	5.15	cents per lb.
"	2.50	"	"	4 95	"
"	2.40	"	"	4.75	"
"	2.30	"	"	4.55	"
"	2.25	"	"	4.45	"
"	2.20	"	"	4.35	"
"	2.15	"	"	4.25	"
"	2.10	"	"	4.15	"
"	2.05	"	"	4.06	"
"	2.00	"	"	3.96	"
"	1.95	"	"	3.86	"
"	1.90	"	"	3.76	"
"	1.85	"	"	3.66	"
"	1.80	"	"	3.56	"
"	1.75	"	"	3.46	"
"	1.70	"	"	3.36	"

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of actual potash.

If quoted at	1.00	cent per lb.	Actual Potash costs	3.77	cents per lb.
"	1.05	"	"	3.96	"
"	1.10	"	"	4.15	"
"	1.15	"	"	4.34	"
"	1.20	"	"	4.53	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since January, 1890. The price given for each month is the average of the four weekly quotations of that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 16.0 per cent. nitrogen, and muriate of potash 50½ per cent. of actual potash or 80 per cent. of the pure salt.

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Wholesale Prices of Fertilizing Materials.

		Cost of Nitrogen at wholesale in						Cost of Potash at Wholesale in			
		Dried Blood.									
		Red. Cents per pound.	Black or low grade. Cents per pound.	Azotin or Ammonite. Cents per pound.	Concentrated Tankage. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate Potash. Cents per pound.	Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
1890.	January	12.4	11.9	12.7	....	12.1	15.4	3.64	4.44	4.97	4.06
	February	12.4	11.8	12.5	....	12.0	15.4	3.64	4.44	4.97	4.06
	March	12.1	11.8	12.2	....	11.9	15.4	3.64	4.44	4.89	4.06
	April	12.0	11.7	12.2	....	11.2	15.4	3.64	4.42	4.77	4.06
	May	11.9	11.3	12.2	....	11.2	15.3	3.62	4.42	4.77	4.05
	June	11.9	11.4	12.1	....	11.2	15.8	3.62	4.42	4.77	4.00
	July	11.9	11.4	12.0	....	11.2	16.6	3.62	4.42	4.77	3.69
	August	11.6	11.0	11.5	....	11.0	16.6	3.62	4.42	4.77	3 69
	September	11.3	10.7	11.3	....	11.1	16.6	3.62	4.42	4.77	3.69
	October	11.4	10.8	11.7	....	11.6	16.5	3.62	4.42	4.17	3.69
	November	11.5	10.9	11.4	....	11.6	16.5	3.55	4.27	4.06	3.69
	December	11.5	10.9	11.4	....	11.6	16.5	3.62	4.53	4.31	3.69
1891.	January	11.0	10.5	11.5	....	10.9	16.5	3.58	4.53	4.33	3.69
	February	12.0	11.0	11.5	....	12.5	16.5	3.58	4.53	4.33	3.69
	March	12.5	11.9	11.5	....	14.3	16.5	3.68	4.53	4.33	3.69
	April	12.4	12.0	11.5	....	14.4	16.5	3.68	4.53	4.33	3.69
	May	12.3	11.7	11.5	....	13.6	16.0	3.68	4 53	4.33	3.69
	June	12.3	11.7	11.5	....	13.2	15.5	3.68	4.53	4.33	3.69
	July	12.2	11.6	11.5	....	12.2	15.4	3.68	4.53	4.33	3.69
	August	12.3	11.8	11.5	...	11.3	15.4	3.68	4.53	4.33	3.69
	September	12.3	12.0	11.5	....	12.2	14 8	3.68	4.53	4 33	3.69
	October	12.3	12.0	11.5	....	13.6	14.7	3.68	4.53	4.33	3.69
	November	12.6	12.3	11.5	....	13.5	14.7	3.68	4.53	4.33	3.69
	December	12.4	12.1	11.5	....	13.3	14.7	3.63	4.63	4.41	3.69
1892.	January	12.2	11.5	11.5	....	12.9	14.7	3.62	4.79	4.45	3.69
	February	11.6	11.3	11.5	....	12.0	14.7	3.64	4.77	4.48	3.69
	March	11.5	11.0	11.2	....	12.1	14.7	3.71	4.77	4.48	3.69
	April	11.8	11.3	11.2	....	11.0	14.7	3.78	4.77	4.48	3.69
	May	12.0	11.5	11.2	....	10.5	14.7	3.78	4.77	4.48	3.69
	June	11.7	11.2	11.2	....	10.6	14.7	3.78	4.77	4.48	3.69
	July	12.1	11.7	11.2	....	11.1	14.7	3.78	4.77	4.48	3.69
	August	12.3	12.1	11.2	....	11.7	14.7	3.78	4.77	4.48	3.60
	September	12.4	12.0	12.0	....	12.4	14.2	3.78	4.77	4.48	3.30
	October	13.0	12.6	12.6	....	12.9	14.0	3.78	4.77	4.48	3.30
	November	14.1	13.8	13.7	....	13.7	14.0	3.78	4.77	4.48	3.30
	December	14.6	14 2	14 8	....	13.7	14.0	3.78	4.77	4.48	3.30
1893.	January	16.2	15.8	15.9	12.3	13.8	14.0	3.51	4.25	4.70	3.33
	February	18.5	18.0	17.9	15.7	14.1	14.0	3.56	4.32	4.16	3.09
	March	20.0	19.8	19.6	19.3	14.7	15.6	3.56	4.32	4.16	3.09
	April	18.0	17.7	18.1	19 3	14.6	17.1	3.56	4.32	4.16	3.09
	May	16.2	15.4	16.4	18.3	13.0	17.1	3.56	4.32	4.16	3.09
	June	14.5	14.0	14.8	14.2	11.0	15.9	3.75	4.32	4.16	3.09
	July	13.7	13.1	13.7	14.2	11.1	14.9	3.75	4.32	4 16	3.09
	August	13.5	12.1	13.9	14.2	11.4	15.6	3.75	4.25	4.16	3.09
	September	12.5	12.2	13.2	14.2	11.6	15.9	3.75	4.32	4.16	3.09
	October	16.2	15.3	15.3	17.1	11.9	16.4	3.75	4.32	4.16	3.09

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REPORT OF THE MYCOLOGIST,

W. C. STURGIS.

It is rarely that a Station mycologist has to report for two successive seasons any decided paucity of actual results owing to lack of conditions favorable to field experiments. Nevertheless such has been the case in Connecticut during the last two seasons. The summer of 1893 was marked by a long continued period of dry weather in June and July, when under favorable conditions parasitic fungi begin their most serious depredations, while the memorable gales of August and early September largely denuded fruit-trees of their crop and made it impossible to obtain accurate data as to the results of comparative spraying experiments.

SPRAYING FOR "SCAB" OF APPLE AND PEAR.

The experiments undertaken under this head were designed to test the comparative value of winter and summer treatment for the prevention of the "scab" fungi, *Fusicladium dendriticum*, (Wallr.) Fckl., and *F. pyrinum*, (Lib.) Fckl. The experiment upon apples was made in the orchard of Mr. A. J. Coe of Meriden, and that upon pears in the orchard of Mr. A. E. Plant of Branford.

The same plan was adopted for both experiments. The portion of the orchard selected for the purpose was divided into four equal parts; the first received during the last week in March a spray consisting of a simple solution of copper sulphate in the proportion of one pound to twenty-five gallons of water; the second received the same, and in addition was sprayed with Bordeaux mixture as usual during the summer; the third was kept as a check and received no treatment whatever; and the fourth received only the summer treatment with Bordeaux mixture.

Both sets of experiments progressed favorably until August, when a succession of violent storms almost completely stripped the trees of fruit, and it was impossible to obtain conclusive results. Enough was seen however to warrant our recommending the use of the simple copper solution early in the spring before the buds begin to swell.

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The following is Mr. Plant's report of the experiment in his pear orchard: "The gales destroyed the opportunity of seeing the best results; at the same time we could readily see the benefit to the foliage and the remaining fruit. One thing is certain, and that is that wherever the Bordeaux mixture is used it shows good results. The plot where the winter treatment was used alone, seemed to me a failure as the fruit was not as nice and the leaves began falling in August. The plots upon which Bordeaux mixture was used were much better. It was applied first just before the blossoms opened, and again when the pears were as large as peas. I think it would have been of benefit to have given them three and perhaps four treatments as the fungus forms very fast on the fruit. I could see little difference between the plot which received both the winter and summer treatment and that which received the latter only. The check plot showed fungus by the wholesale, fruit and foliage being destroyed entirely. I hope next year to have better results."

On the whole the winter treatment would seem to be of little advantage, but it must be remembered that in this case the check rows infested with "scab" were in the midst of the treated rows and were naturally a fruitful source of infection throughout the summer. The fungus produces several crops of spores during the season, any one of which might serve to infect the trees which did not receive the Bordeaux mixture. If there had not been this adjacent source of infection the beneficial effect of the winter treatment would have been more apparent. Again, countless spores of the "scab" fungi live throughout the winter in the inequalities of the bark of infested trees; these are to a large extent destroyed by the early application of the copper sulphate solution, and we start at least with our orchard comparatively free from the germs of disease. Finally, inasmuch as sources of infection are unfortunately never absent, this initial treatment is not sufficient of itself, but must be followed by at least three applications of Bordeaux mixture during the summer.

These experiments will be repeated next season.

Potato "Rot" and Methods of Applying Bordeaux Mixture. Plate I.

Our experiments upon potato "rot" (*Phytophthora infestans*, (Mont.) D. By.) this year were not designed so much to confirm the fact of the value of Bordeaux mixture, a fact already

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abundantly proved, as to encourage its more general use, and to test the value of a new apparatus for applying the mixture to potatoes on a large scale. The experiments were tried at the suggestion of Mr. Thomas J. Stroud, on an eight-acre field of potatoes at Shaker Station. As a demonstration of the value of Bordeaux mixture the experiment could hardly be called a success. The vines suffered so severely from the excessive drought of June and July that though there was no *Phytophthora* present either on the sprayed vines or on those left as checks, they all succumbed and were past recovery by the time August came with more frequent rains.

The vines were also damaged by the "flea-beetle" (*Crepidodera cucumeris*), which usually accompanies a season of severe dry weather; large numbers of plant-lice (aphides), which originated on the abundant "pig-weed" (*Amarantus*); and by a species of blight similar in general appearance and effects to that supposed to be caused by the fungus *Macrosporium Solani*, El. & Mart.* Whether or not the latter is a case of primary cause and effect must still be considered an open question. The blight usually appears first on the tips and margins of the leaflets, and around the eroded edges of the holes caused by the attacks of the Crepidodera. Leaves obtained from many localities throughout the State, and exhibiting the blight in every stage of development, were submitted to the most careful microscopic examination, but in very few instances was the Macrosporium found, and then in hardly sufficient quantity to warrant the assumption that it was the sole cause of the blighted appearance, especially in view of the fact that in no case was it found associated with the most seriously damaged leaflets. Chester† however, claims to have produced the blight by artificial infection with the Macrosporium spores, though he has as yet given no details of the experiment.

Whatever the cause, Bordeaux mixture seemed inefficient in preventing it, and experiments on the subject will be undertaken another season with added interest.

Apparatus for Spraying Potatoes.

The need has long been felt of some mechanical device for applying fungicides or insecticides to low-growing plants, especially when the latter are planted at regular intervals, either in

* *Cf.* Sixth Annual Report Vt. Agr. Exp. Sta., 1893, p. 66 refs.

† Bull. XV. Del. Agr. Exp. Station, Jan., 1892, p. 14.

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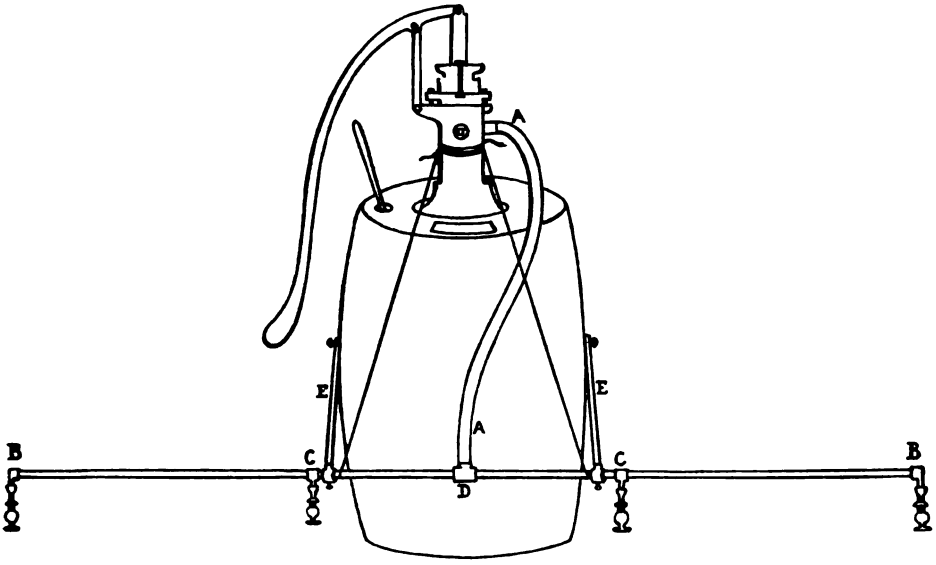
rows or otherwise. A knapsack sprayer is thoroughly satisfactory only over small areas, as it requires frequent refilling, and when filled is too heavy to carry continuously for more than a few hours. The barrel pump mounted on a cart is far more satisfactory for spraying potato-fields of five acres and upwards, but even with two discharge-pipes the work is slow and requires at least three men to do it properly. What is needed is an apparatus which will cover four or five rows at a time, the spray being delivered from fixed nozzles, one directly over each row, and requiring for its operation only one man to pump and one to drive. Such an apparatus is shown in the accompanying cut and in Plate I, and after testing it severely for one season we can vouch for its capabilities.

It consists essentially of a cask upon which is mounted a force-pump of considerable power fitted with one discharge carrying a one-inch rubber discharge-pipe, A. This pipe is from two to



three feet long and connects directly with the distributing pipe, BB. The latter is composed of half-inch brass tubing cut into four joints, two of them measuring three feet in length, the others eighteen inches each. Elbow-connections at B, and T-connections at C, connect the joints of the pipe and carry quarter-inch couplings fitted with Vermorel nozzles. Each nozzle thus covers one

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row of potatoes when the rows are planted three feet apart as is customary. The pipe may be lengthened to twelve feet and carry five nozzles, but except where some special conditions render it advisable, as when five rows of potatoes occupy the space between rows of trees in an orchard, the longer pipe will be found inconvenient. A T-connection at D unites the two shorter joints of the pipe and connects the pipe with the discharge-tube A. This allows each half of the distributing pipe to be turned and the sprays directed either downwards or outwards. The distributing pipe is connected with the barrel by two iron rods, E. These rods are clamped to the sides of the barrel with thumb-screws, and where they connect with the distributing pipe they screw into brass collars. When these collars are set by means of thumb-screws the pipe becomes fixed in the desired position. When the thumb-screws on the barrel are loosened the whole distributing pipe can be raised up over the barrel thus checking the discharge when desired and facilitating the turning of corners, passage through narrow gates, etc. Two light ropes attached to the pipe enable the man who pumps to raise or lower the pipe at will. The length of the rods, E, depends upon the style of cart in which the barrel is carried. They must be long enough to keep the distributing pipe at least a foot beyond the rear of the cart.*

This apparatus is very simple; it can be made by any gas-fitter at a cost, exclusive of the pump and barrel, not exceeding ten or twelve dollars; and it is easily operated by two men, one to drive and the other to pump. With it we have covered an eight-acre field of potatoes in seven hours, including the time occupied in making up the Bordeaux mixture for each of the nine barrel-fulls used. Two men could easily cover ten or twelve acres a day, the mixture being distributed thoroughly and continuously at the average walking speed of a horse.

In practice it will be found advisable to direct the spray outward at an angle of about 45° instead of directly downwards, as by this means advantage is taken of the full width of each spray. For the same reason, when the potatoes are almost or fully grown, the distributing pipe should be raised and fastened in a

* In ordering Vermorel nozzles for use with this apparatus it is well to have them fitted with a spiral spring to hold back the degorger; otherwise the position of the nozzle allows the degorger to fall forward, choking the aperture and causing much delay in readjusting it.

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position not less than three feet above the tops of the plants. In this connection it should be stated that an apparatus very similar to that described was this year devised quite independently of us by Mr. Wm. Platt of Milford. The distributing pipe is made precisely like ours, but instead of being permanently fixed to the barrel, it is connected to the latter only by two quarter-inch rubber discharge-pipes, and is carried by a man walking behind the cart. It requires one additional man, but it is somewhat cheaper than our apparatus and quite as serviceable. The delivery-pipe can be made to carry five nozzles without inconvenience, and it is more completely under the control of the operator. Either apparatus serves its purpose well and is certainly an improvement over the methods heretofore used. Our apparatus in use is illustrated in Plate I.

Mildew of Lima Beans.

(*Phytophthora Phaseoli*, Thaxter.)

Experiments were undertaken to test the value of various fungicides in preventing this "mildew" which for some years has caused considerable loss to truck-farmers in various parts of the State.

Bordeaux mixture, copper acetate, potassium sulphide, flowers of sulphur, and a powder prepared by F. C. Boucher & Co., of St. Paul, Minn., and sent out under the name "Par 'Oidium," were all tried on beans growing in New Haven and Cheshire. The result was merely to show what could be used safely without damage to the vines, for no "mildew" appeared either on the treated or untreated vines, nor could we hear of its occurrence in the neighborhood even in localities where it has always been abundant. As usual Bordeaux mixture gives the best promise, doing no damage to the foliage or pods and adhering well.

Treatment of Grape-vines under Glass.

Early in the season we were notified that "mildew" (*Plasmopara viticola*, (B. & C.) Berl. & DeTon.) had made its appearance on Hamburg grapes grown under glass by Miss M. M. Augur of Whitneyville. A visit to the greenhouse resulted in a recommendation to apply Bordeaux mixture. The vines at this time were in very full leaf, and the flowers in bud; the former were badly mildewed and already beginning to turn brown. The Bor-

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deaux mixture was applied twice, the proportion used being 6 lbs. of copper sulphate and 45 galls. of water, but notwithstanding this small proportion of copper the vines were badly burned, and by July it seemed as though they would prove a total loss. We then had the remains of the Bordeaux mixture thoroughly washed off with water, and as every leaf and young cluster which the mixture had spared was still more or less affected with the fungus we recommended sulphur fumes. The greenhouse was closed and the sulphur allowed to boil in a shallow dish for about five minutes. The result was the complete recovery of the vines, and a good crop of sound fruit. Our experience is worth recording as illustrating not only the deleterious effect of even weak Bordeaux mixture on the delicate foliage of greenhouse grapes, but also of the value of sulphur fumes in the treatment of plants under glass. It should also be mentioned that the previous liberal use of dry sulphur dusted on the vines had had little or no effect on the "mildew."

Quince Diseases.

"Black rot" (*Sphaeropsis Malorum*, Peck).

Last year we mentioned the occurrence of this wide-spread decay in a quince orchard in Cheshire, and recommended late spraying with Bordeaux mixture or the ammonia solution of copper carbonate. Pressure of other work prevented our proposed experiments in preventing this disease, but a study was made of the fungus itself. As has already been pointed out by Halsted,* the rot is not confined to the quince, but is common upon apples and pears, upon both of which we found it growing very abundantly. That the fungus is one and the same on all three fruits is abundantly proved by our inoculation experiments which confirm those undertaken by Halsted (l. c.). These inoculations were made both in the laboratory and in the field; quinces were inoculated with spores of the fungus on apples and *vice versa*, and in every case where the spores were introduced under the skin, or the skin injured in any way before inoculation, the fungus grew and spread with great activity. When the skin was not broken, and the spores merely placed in a drop of water on the intact surface, they failed to effect an entrance and the fruit remained sound. The conclusion is obvious. Fruit affected with this rot

* Bull. 91, N. J. Agr. Coll. Exp. Station, Dec., 1892, pp. 8–10.

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falls early and is allowed to remain where it falls, being merely "rotten fruit." From this fruit the wind or other agencies carry the fungous spores, and a single apple-tree may readily infect a whole quince orchard. It is therefore necessary to say again that all such "rotten fruit," whether of quince, apple, or pear, should be carefully gathered and burned. This year the "rot" appeared in the quince orchard even though the trees had been thoroughly sprayed with Bordeaux mixture, and it therefore seemed advisable to ascertain whether the fault lay in the fact that the treatment was not made late enough, or in the resistancy of the spores to solutions of copper salts. This was readily proved by sowing spores in water and in copper solutions of various degrees of strength in moist chambers or cells. The results showed that whereas the spores germinated within a few hours in clear water and produced a dense mycelium, in water containing 0.03 per cent. of copper sulphate they failed to germinate at all. In a 0.025 per cent. solution about 10 per cent. of the spores were found to have germinated at the end of 6 hours, and about 50 per cent. in 24 hours, but the hyphæ which they produced were short and much knotted and distorted, the solution being almost fatal; in a 0.02 per cent. solution about 50 per cent. of the spores germinated in 6 hours, but as in the previous case all growth ceased within 36 hours. It is evident then that a solution containing 0.03 per cent. or more of copper sulphate is fatal to the "rot" fungus of the quince, apple, and pear. Bordeaux mixture made in the proportion of 6 lbs. of copper sulphate to 50 galls. of water contains 1.5 per cent. of the copper salt, and though changed by the action of the lime to copper hydroxide, it would be sufficient in this case, if in any, to act as a very powerful fungicide if brought thoroughly into contact with the fungous spores.

"Scab" of Quinces.

(*Fusicladium* sp.)

It is always a matter of regret to be obliged to record either a new locality for a destructive fungus, or the harmful nature of a fungus hitherto considered of little economic importance, yet we have to make this record in the following instance. Early in June a number of quince-leaves were sent to us for examination from Tolland. Some of the leaves were completely brown and

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dead, in others the discoloration had just begun at the tips and was spreading downwards. The letter accompanying the leaves stated that "the bushes look as if something had been thrown over them." At first the trouble seemed due to some peculiar condition of the soil or atmosphere rather than to any fungus, but careful search revealed the presence of copious fungous threads rising from the surface of the leaf, and bearing upon their tips brown, two-celled spores. The fungus resembles the common "scab" fungus of the apple (*Fusicladium dendriticum*, (Wallr.) Fckl.). It was impossible to determine the fungus with any certainty, and until another season presents further opportunities for a critical study of the species and methods of treatment, we would merely call the attention of growers to this new trouble, and recommend Bordeaux mixture as in the case of the similar "scab" of apples and pears.

Quince-leaf Miner. Plate II.

(*Aspidisca splendoriferella*).

Although it is out of the province of the mycologist to treat of injuries due primarily to insects, the damage caused this season by the larvæ of this moth in at least one locality, was so serious as to call for some notice.

About the middle of September we received from Mr. N. S. Platt of Cheshire a number of quince-leaves completely riddled with holes varying from one-eighth to a quarter of an inch in diameter. Although noticed so late, a visit to the orchard showed that the larvæ had already worked great damage, and in the end the assimilative activity of the leaves was largely checked a month or more before the usual period. Specimens of the leaves were sent to the Department of Agriculture by Mr. Platt, and we quote the following from the reply of Prof. Howard of the Division of Entomology:

"The adult insect is a little moth which lays its eggs in the leaves of apple, quince, pear, and other rosaceous plants. The egg hatches into a minute larva which mines between the two surfaces of the leaf. It then cuts through both surfaces around the edges of its mine, and fastens the edges together, leaving an orifice for its head. Finally, cutting free entirely from the leaf and leaving a round hole, the larva migrates with its case to the leaves and branches of the tree, where it passes the winter.

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There is ordinarily no necessity for any remedy against this insect, as its worst work is done comparatively late in the summer. When however, they occur in extraordinary numbers it is a comparatively easy matter to scrape the cases from the trunk and main limbs, and thus greatly reduce the numbers of the potential moths of next summer. If, instead of being scraped, the tree be sprayed with strong kerosene emulsion after the leaves have fallen, most of the cases will be penetrated by the oily mixture, and the enclosed larvæ killed."

In connection with this insect injury, there were constantly two species of fungi which further increased the damage to the leaves. The more noticeable of these was a fungus apparently belonging to the genus Phyllosticta, though it was in so immature a condition that accurate determination was impossible. It presented the appearance of minute black pimples occupying the centres of round grayish spots upon the upper surface of the leaves. The other fungus, known as *Hendersonia Cydoniae*, Cke. & Ell., invariably occupied the edges of the holes caused by the Aspidisca, and rapidly invaded the adjoining tissues. Both of these fungi probably attacked the leaves after the last treatment with Bordeaux mixture had been given; nevertheless much of the latter still adhered to the leaves, often on the very spots occupied by the fungus. We therefore hesitate to recommend any line of treatment at present, except the general one of gathering and burning all fallen leaves.

Leaf-Blight of Celery.

(*Cercospora Apii*, Fres.)

Experiments were repeated this year, under our direction, by Mr. G. T. Hubbard of Middletown, to check this blight by means of certain fungicides. The fungicides used were potassium sulphide solution, a dilute solution of copper sulphate, and dry sulphur dusted on the plants. The latter treatment proved the most efficacious last year, but it was thought advisable to repeat the test and secure, if possible, conclusive results. On September 8th we received from Mr. Hubbard a number of leaves taken from plants which had received the potassium sulphide and copper sulphate treatments; they all exhibited a copious growth of the fungus in an advanced stage. The letter accompanying the diseased specimens says: "The celery on which I dusted sulphur is perfect. I see no signs of blight and I am now using sulphur on

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all my crop. I am fully convinced it is the thing." It now only remains to be seen whether the like good results would be obtained by the use of sulphur during a wet season. Both of our experiments were made in a very dry season, though in each case the fungus was present in quantity.

Tobacco.

Another season marked by conditions most favorable to the rapid and complete curing of tobacco rendered futile further investigation of the causes of "pole-sweat," and the value of artificial heat in altering the conditions favorable to its inception. We were however, enabled to try the effect of artificial heat on the temperature and relative humidity of the air in a tightly closed barn filled with green tobacco. Although these experiments throw little additional light upon the prevention of "pole-sweat," they are of interest as proving that a simple system of furnaces and flues adapted so as to distribute heat evenly over the ground area of a closed curing-barn, are sufficient to regulate the temperature and the relative amount of moisture held by the air of the barn; and as was shown in a previous report, the growth of the organism presumably the cause of "pole-sweat" can be controlled by such regulation of atmospheric conditions. The tobacco in the experimental plots was cut and hung in the barn Aug. 30th–Sept. 1st, and a week later the first observations were made.

Temperature and relative humidity determinations were made at each end of the barn outside; and inside at both ends and in the middle of the floor, the second tier, and the roof-space or "purline," very fair averages being thus obtained.

The first set of observations showed for the outside atmosphere an average temperature of 57° F., and an average relative humidity of 70. Inside, the atmosphere of the tightly closed barn showed an average temperature of 54° F., and relative humidity 82. The interior of a closed barn filled with green tobacco is therefore considerably cooler and under conditions of fair weather contains much more moisture than the exterior air; if the temperature is sufficiently high therefore, the conditions of moisture in the barn are favorable to the spread of "pole-sweat."

The end doors of the barn and the lowest row of ventilators were then opened, and within half an hour the temperature six feet above the floor had risen to within a degree of that outside,

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and the relative humidity had fallen to 86 as compared with 91 when the barn was completely closed. The opening of the ventilators, therefore, in fair weather, exercises a rapid and decided influence in raising the temperature and decreasing the moisture of the interior of the barn.

Finally, the barn was tightly closed, and brisk fires started in two of the four furnaces, that is in one set of flues. One hour after lighting the fires the following observations were recorded six feet above the ground: Average relative humidity 69, average temperature 71.5°. In other words, by using only half the available heating facilities for one hour, the relative humidity of the interior of the barn at a height of six feet from the ground was reduced from 91 to 69. The accidental breaking of the hygrometer prevented our taking, as before, observations at different levels, but there is no reason for supposing that the proportions would have varied essentially though more moisture would have been found above, forced up by the warmer air below. It must be remembered also that these observations were made during clear and comparatively dry weather.

In conclusion we are justified in considering that under the atmospheric conditions most favorable to the development of "pole-sweat," the temperature and moisture in the interior of a closed barn can be so regulated by artificial heat as to reduce to a minimum the liability of curing tobacco to damage from fungi and other like organisms.*

* The following table is compiled from our observations made in the interior of the barn under various conditions. The temperature is given in degrees Fahrenheit. The relative humidity of the external air averaged 70; the temperature at the beginning of the observations was 57.5°, and rose slightly during the course of the observations.

Experiment 1.	Floor.	2d tier.	Purline.	Average.	Remarks.
Temperature...	49.5°	52.°	61.4°	54.3°	Barn completely closed.
Rel. humidity..	91.	87.	68.	82.	
Experiment 2.					
Temperature...	57.7°				End doors and lowest tier of ventilators open, and observations taken at end of one-half hour.
Rel. humidity..	86.				
Experiment 3.					
Temperature...	71.5°				Barn closed. Two furnaces fired for one hour and then observations taken.
Rel. humidity..	69.				

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Further Notes on the Cause of "Pole-sweat" and "Stem-rot" of Tobacco.

Since the publication of our preliminary report upon this subject,* the results have been published of similar investigations by Dr. Behrens of the Experiment Station at Karlsruhe, Germany.† As his results seem in a measure to conflict with ours some remarks on the subject seem advisable.

Behrens considers, and supports his conclusions by the results of inoculations, that there are two nearly related fungi which cause a decay of curing tobacco, *Sclerotinia Libertiana*, Fckl., and *Botrytis cinerea*, P. The process of decay is the same in both cases, but Behrens infers that when the fungi attack the mid-rib or veins of the leaf the effect corresponds to that which we described under the name of "stem-rot," and when they attack the leaf-tissue the effect produced is called "pole-burn." First, regarding "stem-rot." It must be noted that Behrens' observations were made upon tobacco leaves cured, according to the continental method, separate from the stalks; he therefore says nothing of fungi which attack the stalk proper, and it may be fairly assumed that the "stem-rot" (Rippenfäule) of Behrens corresponds more to what we described as "pole-burn." The latter, as we have stated, he attributes to the growth of *Botrytis* and *Sclerotinia*, the one a conidial or spore-bearing fungus, the other an indurated, sterile mass of fungous threads which under certain conditions may produce spores of the Botrytis type.

In our preliminary report we described "stem-rot" and attributed it to the only fungus found in connection with it, viz: *Botrytis longibrachiata*, Oud. To explain this seeming contradiction in results, Behrens offers the suggestion that *Botrytis longibrachiata*, Oud., and *B. cinerea*, P., are identical; but no one who had ever compared the two could possibly mistake the one for the other. They are totally distinct in habit, color and organs of reproduction; *Botrytis cinerea* was never found by us associated with "stem-rot;" and our view is further strengthened by the fact that we have found *Botrytis longibrachiata* growing parasitically on living herbage and inducing changes which finally resulted in the death and decay of the plant attacked.

* Conn. Agr. Exp. Station, Annual Report for 1891, p. 168.

† Dr. J. Behrens. Trockene und nasse Fäule des Tabaks. "Der Dachbrand." Zeitschrift für Pflanzenkrankheiten, Bd. III, Heft 2, p. 82.

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With regard to "pole-burn" (Dachbrand), the results of Behrens' observations seem to be conclusive. In the cases investigated by him the decay was undoubtedly due to the *Sclerotinia* and the *Botrytis cinerea*. But even here the question allows of considerable difference of opinion. Decay of curing tobacco has been variously ascribed by different observers to *Pleospora* sp., *Botrytis vulgaris*, Fr., and two species of the genus *Mucor;* while several other fungi are known to occur on drying and dry tobacco leaves. In a letter to us, Behrens states as probable that several different fungi may induce decay, and in the cases which we studied there were found occasionally in the decayed tissue of the leaves, remains of fungous threads similar to those of *Cladosporium* and related genera (possibly *Botrytis*), and more rarely still, a few scattered sclerotia which, however, could not be induced to produce any reproductive organs. Finally, whatever be the initial cause of decay its existence would seem to be of short duration, for the leaves from which we drew our conclusions were examined within forty-eight hours of the first appearance of disease, and the process of decay went on rapidly without any further growth on the part of the remains of fungous threads in the tissue, and without the development of any other fungus whatever, but associated constantly with the rapid development of bacteria of two forms. We are therefore convinced that although the initiative in "pole-burn" may be taken by a *Botrytis* or some similar fungus, the preliminary growth of which may even be essential to the succeeding condition of decay, the latter is largely bacterial in its nature.

Miscellaneous Notes.

Asters.—Last year we studied a wide-spread disease of Asters and other plants of the order *Compositae*, and concluded that it was due to a parasitic nematode worm of the genus *Aphelenchus* which produces galls upon the roots, and eventually causes the death and decay of the internal tissues of the stems. The disease is commonly known among growers as "white-legs," owing to the bleached and spindly appearance of the affected plants. As a result of our investigations and those of other observers we stated that the cause of disease was increased by the use of animal manures, especially on old land, and would be largely controlled by the use of lime or plaster.

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Through the kindness of Messrs. F. P. Burr & Co., of Middletown, field experiments were made this year, but they unfortunately proved inconclusive owing to the apparently sporadic nature of the nematode attacks. Asters were grown under the following conditions. (1) On a mixture of old garden soil, sand, and ground plaster, and fertilized with superphosphate; (2) on soil thoroughly impregnated with coal-ashes; (3) on new turf land, fertilized with horse-manure and peat-moss bedding.

On none of these plots was there any sign of either the "blue aphis" or the nematodes. Last year it was difficult to find anywhere a bed of asters quite free from disease; this year, under the same conditions, the reverse was true.

After long experience however, in the culture of asters, Mr. Burr comes to the following conclusions which are borne out by the results of recent investigations abroad. "Asters are very uncertain on old soil with stable manures, but are quite sure to prove good with *plenty* of lime and artificial manure on old land, and with artificial manure on new land."

Aster Beetles, (*Cantharis atrata.*)—This beetle was common during the past season on asters, causing great damage to the flower-heads. It is of a dull black color, of rather slender form, about half an inch in length, and provided with two long, knotted antennæ. When handled the beetles emit a yellowish fluid of disagreeable odor. They belong to the Cantharides, or "blister-beetle" family. They do not confine their depredations to asters, but are commonly found on certain species of golden-rod, and occasionally commit serious ravages on potatoes. None of the ordinary insecticides seem to be of much value in preventing the attacks of the Cantharis; a better method is to shake or brush the insects from the plants into shallow pans containing kerosene.

Fungi attacking roses.—Two fungi have been very prevalent this year on cultivated roses, the rose "rust" (*Phragmidium subcorticium*, (Schrank) Wint.), and the "black-spot" (*Actinonema Rosae*, (Lib.) Fr.). The former appears early in the season, producing on all the more delicate parts of the plant bright orange masses of spores, and characteristic distortions of the parts affected; the latter appears on the leaves as roundish black or gray spots and patches, sometimes involving the whole leaf.

Most of the "rusts" are peculiarly resistent to fungicides, but both the rose "rust" and the "black-spot" could probably be in

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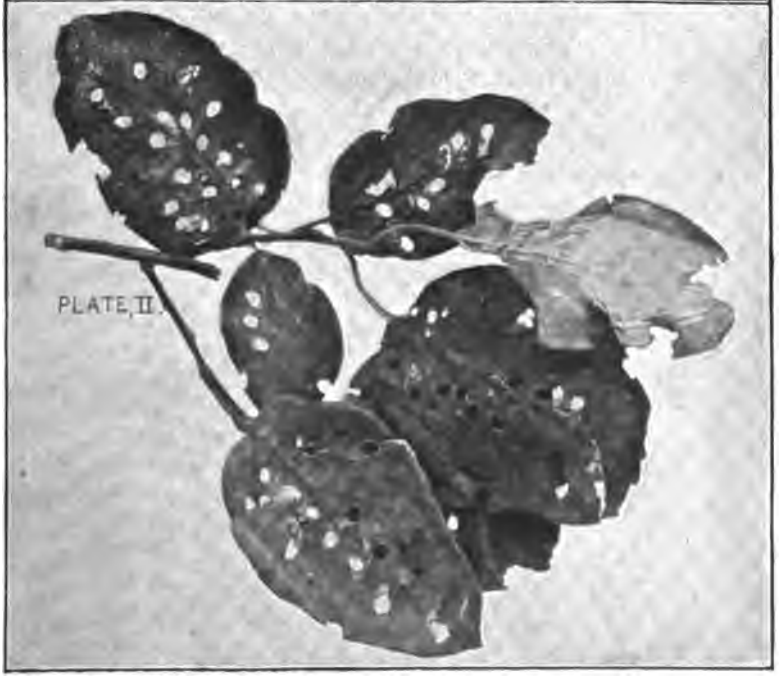
PLATE, I



PLATE, II.

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a measure checked by the early application of the copper sulphate solution followed by Bordeaux mixture or the ammonia solution of copper carbonate, and in the case of the "rust" by cutting out unsparingly all the diseased parts of the plant.

Notes on the Bordeaux mixture.—The only trouble which, so far as we know, attends the use of Bordeaux mixture, is the clogging of the nozzle due to the large excess of lime in suspension, or rather to the presence of coarse particles in the lime. It is essential to use a large quantity of lime and for two reasons, viz:

1. To decompose all the blue vitriol, which itself would destroy the foliage it is desired to save, and to produce in its stead the mild poison—copper-hydroxide—which kills the fungus without injury to the host.

2. To take advantage of the cementing quality of slaked lime, which makes the copper-hydroxide adhere to the foliage for a considerable time.

To prevent clogging of the spraying nozzle, it is sufficient, after slaking the lime with six gallons of water and stirring well, to let the "milk of lime" stand a few minutes so that any grit or coarse matters may have time to settle, and to pour off only the fine slaked lime into the copper sulphate solution.

It was thought however, that all danger of clogging might be averted by slaking the lime with almost the whole quantity of water used for the mixture, allowing it to settle, and then pouring into the copper solution only the clear lime water. This would be feasible only if the quantity of water used to slake the lime could dissolve enough of the latter to precipitate all the copper sulphate. If any of the sulphate remains in solution there is, of course, danger of burning leaves to which it is applied. This method was tried, using the proportions most commonly recommended; the greater part of the water was used in the slaking of the lime, and only the clear solution after being allowed to settle for twenty minutes was poured into the sulphate solution. In no case was the latter completely precipitated. In order to test the adhesive quality, several gallons of the mixture were made up by this method; and a like quantity by the usual method, using a large excess of lime in suspension. The mixtures were applied simultaneously to two sets of vines, where the superiority of that containing an excess of lime was readily demonstrated in its adhesion to the foliage two weeks longer than the other and through one heavy rain.

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COMMON FUNGOUS DISEASES AND THEIR TREATMENT.*

By William C. Sturgis.

Two years ago the demand on the part of the farmers and fruit-growers of the State, for a concise and untechnical statement concerning the more common fungous diseases, the means of recognizing them, and the methods of treatment, was answered by Bulletin No. 111. The science of economic mycology makes rapid progress, fungous diseases hitherto unknown in a certain locality become prevalent, and the experiments of a year may so far increase our knowledge, that in order to secure the best results from the use of fungicides, we must be prepared to keep abreast of the latest investigations, and modify our methods accordingly. It has therefore been decided to publish this revised edition of Bulletin 111, only such changes from the latter publication being made, as subsequent experience has proved advisable.

DISEASES OF THE APPLE.

"Scab." [*Fusicladium dendriticum*, (Wallr.) Fckl.]

This disease attacks the leaves and fruit of the apple, producing roundish or irregular blotches on the upper surface of the leaves, and on the fruit. These blotches are of a dark greenish-brown color, and of a more or less velvety texture. The growth of the fungus causing these blotches does not tend to produce any rapid or widespread decay in the fruit, but it does stunt and distort the fruit, rendering it to a greater or less degree unsightly and unmarketable. The "scab" should not be confounded with the diseases known as "bitter-rot" and "black-rot," both of which tend to produce rotten areas in the fruit.

Treatment.

Inasmuch as the "spores" or fruit of the "scab" fungus pass the winter in the fallen leaves beneath the trees or in the cracks and

* The following matter regarding fungous diseases and their treatment was first published in 1892 as Bulletin No. 111. It was revised and issued as Bulletin No. 115 in March, 1893. It is now made part of this Report with such slight emendations and changes as seem desirable.

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crevices of the bark, collecting and burning the leaves in winter is of great assistance in controlling the disease, and a winter treatment in the form of a strong wash or spray applied to the trees is most desirable. The material used is a strong solution of either sulphate of copper, 1 lb. to 25 galls. of water, or sulphate of iron, 1 lb. to 5 galls. of water. This application is best made by means of some form of spraying apparatus, and should be used in early spring before the buds have begun to swell.

This should be followed up by a summer treatment, consisting in the application of either the Bordeaux mixture or modified Eau céleste. Formulas and directions for the preparation of these and other fungicides are given on pp. 103–105. The Bordeaux mixture presents one very decided advantage over the modified Eau céleste, in that it contains no ammonia, hence does not dissolve the arsenic compounds, and can therefore be used in conjunction with Paris green or London purple to prevent the attacks of the codling moth as well as of the "scab" fungus. The mixture should be made in the proportion of one pound of the arsenic compound (Paris green or London purple) to 100 gallons of the Bordeaux mixture, the former being stirred to a smooth paste with a little water and added to the latter.

Time of application.

In applying fungicides for apple "scab," it should be remembered that early treatment is extremely important. The winter treatment with sulphate of copper or of iron should take place late in March or very early in April, before the buds begin to swell. The first application in the summer treatment should be made just before the flowers open, a second as soon as the fruit is set (for this application and the following, Paris green may be mixed with the fungicide to destroy the eggs of the codling moth), and a third when the fruit is half grown. The winter treatment, followed by these early summer applications, if carefully and thoroughly made, will be found as efficient as a number of applications later in the season. Prevention is always better than an attempted cure.

DISEASES OF THE PEAR.

"LEAF-SPOT." (*Entomosporium maculatum*, Lév.)

This disease attacks the leaves and fruit of both the pear and the quince, producing on the leaf yellowish or reddish spots

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marked in the center by minute black pimples. The affected leaves fall prematurely, generally by the first part of July, the tree suffers in consequence, and may eventually die from the effects of repeated premature defoliation. Upon the fruit the spots produced by the fungus are not usually as prominent as upon the leaf, but the early falling of the leaves, and the presence of the fungus upon the fruit, causes the latter to become stunted, often badly cracked, and quite unfit for the market. In this State more damage is done to pears by the pear "scab," while quinces suffer more seriously from this "leaf-spot."

Treatment.

Collecting and burning the fallen leaves and fruit after harvest, and a treatment of the trees early in April with a strong solution of sulphate of copper as recommended for apple "scab," tends largely to check the spread of the disease. For the summer treatment either the Bordeaux mixture or the modified Eau céleste will be found effective. The latter is more expensive than the former, and as stated above it cannot be used in connection with the arsenical insecticides without seriously endangering the foliage, but, being a clear solution, it can be applied with great ease, and for late applications is to be preferred to Bordeaux mixture as it does not spot the fruit.

Time of application.

The winter treatment should be made early in April; the first spraying with the Bordeaux mixture or the modified Eau céleste should be made just before the blossoms open; a second, as soon as the blossoms have fallen; and either two or three more at intervals of ten days to three weeks according to the rainfall.

"Scab." [*Fusicladium pyrinum*, (Lib.) Fckl.]

The fungus causing this disease is very closely related to that causing the apple "scab," and the effects of the two are very similar. Upon the pear, as upon the apple, the fungus produces dark brownish patches of a velvety texture on the leaves and fruit. Cool, damp weather is in both cases favorable to the spread of the disease.

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Treatment.

A spray of sulphide of potassium, used in the proportion of one ounce to two gallons of water, has been recommended, but is probably not as effective as the Bordeaux mixture, or the modified Eau céleste. The first application should be made when the flowers are beginning to open, a second when the fruit is about the size of peas, and additional applications every two weeks until five or six in all have been made.

DISEASES OF THE QUINCE.

"LEAF-SPOT." (*Entomosporium maculatum*, Lèv.)

This is the same fungus which causes the "blight" or "spot" of the leaves of the pear, and the cracking of the fruit. In the case of the quince the most marked effect of the fungus is upon the leaves, which blight and fall prematurely, hence the first effect of remedial measures is seen in a vigorous, healthy leafage, and in severe cases a good set of fruit is only secured after spraying for two seasons.

Treatment.

In treating the disease as it occurs on quince trees, experience seems to show that in the end, and taking into consideration the much greater success attending its use, the Bordeaux mixture is preferable to any other fungicide. The use of the Bordeaux mixture is also to be recommended because it permits of admixture with Paris green as a remedy against the quince "maggot." The Paris green should be mixed to a smooth paste with a little water, and then stirred into the Bordeaux mixture in the proportion of one pound of Paris green to 100 gallons of the mixture.

This treatment should be supplemented by the gathering and burning of the fallen leaves, and by the winter treatment with sulphate of copper or sulphate of iron as recommended in other cases, p. 89.

The proper times for making the applications are the same as in the case of the "leaf-spot" of the pear, p. 90.

"BLACK-ROT." (*Sphæropsis Malorum*, Peck.)*

This disease, which also attacks apples and pears, has only recently made its appearance on quinces in this State, but it bids

* See Bull. 91, N J. Agr. Exp. Sta., p. 8.

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fair to become a serious trouble to quince growers unless speedily checked. It makes its appearance in August, as a discolored spot, usually on the exposed side of the fruit. The spot spreads rapidly, both superficially and in the interior of the fruit, until the whole fruit becomes brown, decayed, and shrunken, and often badly cracked. The disease once seen, is unmistakable.

Treatment.

The fungus producing the disease in question is nearly related to others which have been carefully investigated, so that it is fair to presume, although the presumption rests upon no definite experiments as yet, that a continuation through August of the application of Bordeaux mixture will effectually prevent the disease. If it is found that this mixture is liable to remain upon the fruit at the time of harvest, the modified Eau céleste or the ammoniacal solution of copper carbonate may be substituted for the Bordeaux mixture with probably quite as good results.

All diseased fruit should be gathered and burned at and after the time of harvest, and if apples or pears are grown in the neighborhood the disease should be carefully looked for upon them and no diseased fruit should be allowed to lie on the ground or remain upon the trees.

DISEASES OF THE PEACH.

Practically the only disease of peach trees which at present seriously threatens the fruit interests of Connecticut is that known as "yellows." It is impossible to give within the limits of the present Bulletin even a brief outline of the investigations which have been made on the cause or causes of this malady. It is sufficient to say that as yet no definite cause has been ascertained with any certainty, and no means have proved effective in checking the spread of the disease except rooting out and destroying by fire every tree which shows the first symptoms of the disease. Constant study has however, given us certain general facts relative to the disease.

(1)* The first manifestation of "yellows" is the premature ripening of the fruit. The moment this symptom is seen, though

* These conclusions are based upon the publications of Prof. E. F. Smith, referred to on the next page.

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the tree is to all appearance sound and healthy otherwise, it must go, if the spread of the disease is to be checked. There are no authentic instances of trees recovering after the appearance of this symptom.

(2) The second evidence of a diseased condition is the premature development of winter buds, producing spindly growths and sickly green leaves. All the other symptoms of "yellows" are due primarily to these two.

(3) The period of incubation, i. e. the time elapsing between artificial inoculation and evident symptoms of disease, is considerable; after the appearance of symptoms the tree may live from one to five years, and even produce fruit during the early stages of the disease.

(4) The whole tree is affected when symptoms appear in any part of it, hence

(5) Pruning has little or no effect on the spread of the disease. If a single diseased tree is allowed to remain in the hope that it will bear fruit for at least one more year, not only are the adjoining trees endangered but the whole orchard and even adjoining orchards may become infected.

(6) There is no question that the disease can be communicated from one tree to another, though how it is communicated, that is, the nature of the contagion, is as yet unknown. It may be communicated even by apparently healthy buds when these are taken from diseased trees, but it is also conveyed in some other way than by bud inoculation, certainly in the case of old trees. Finally the trees are not infected through the blossoms.

(7) The use of special fertilizers has never cured a tree, though heavy fertilizing may, by increasing the vigor of the tree, enable it to withstand longer the effects of the disease.

(8) It is possible to grow healthy trees in the identical spot from which a diseased tree has been taken. This has been the practice of growers in Michigan and the disease has been almost completely eradicated. In other States however, notably in Delaware, the practice has not proved so advisable, and on the whole it seems to be at least unsafe to set out a new tree on the spot where a diseased tree has recently been rooted out.

For further details on this subject the reader is referred to Dr. Erwin F. Smith's exhaustive treatises, Bulletin No. 1, U. S. Dep't of Agric., Division of Veg. Path., and Bulletin No. 9, U. S. Dep't of Agric., Div. of Bot., to which publications we owe most of our

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knowledge concerning peach "yellows." A complete summary of the present status of the subject will be found in U. S. Dep't of Agric., Div. of Veg. Path., Report for 1892, p. 235 *e. s.*

DISEASES OF THE PLUM AND CHERRY.

"Black Knot." [*Plowrightia morbosa*, (Schw.) Sacc.]

This disease attacks the smaller limbs and twigs of wild cherries and plums as well as of the cultivated varieties, producing on them jet black, wart-like growths. At first these growths are small and do but little damage, but they increase rapidly in size; by inducing a morbidly active growth of the tissue of the branch on the side upon which they are growing, they produce a distortion of the branch; and finally, surrounding the branch completely, they produce death. It is not rare for a whole tree to be killed by this disease in the course of two seasons. The black "knots" are largely composed of the fruiting part of a fungus, the vegetative part of which is buried in the tissues of the branch, and occupies a distance of three to five inches above and below the "knot" itself.

Treatment.

After the disease has once obtained a good hold upon the larger branches of a tree it is well nigh impossible to eradicate it. Its spread can be stopped however, if it is taken in hand early, or when the "knots" are still small and few in number.

With a sharp knife the knots should be cut out, the portion removed extending three or four inches above and below the "knot" itself. The wound should then be washed, or the whole tree sprayed, with a strong solution of sulphate of copper, and then painted over with some oil paint.

In place of the oil paint, a paste made of kerosene and some colored pigment, or of turpentine and lime, has been used frequently with marked success even when applied directly upon the "knots" without cutting them out. It is always surer and safer however, first to cut the "knots" out and then to apply the paint or paste to the cut surfaces.

The spores of this fungus mature and are distributed from the latter part of December to February; the best season therefore for cutting out the "knots" is November or early in December.

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The young "knots" appearing in the spring, bursting through the bark in greenish swellings, may be cut out at that season. If the whole tree is badly diseased it should be cut down at once and burned; and the same applies to the individual "knots." If allowed to remain on the ground they will infect healthy trees as readily as though they were still on a living tree. Wild cherries which are diseased should be subjected to the same treatment, or destroyed altogether.

"Mould." (*Monilia fructigena*, Pers.)

This disease attacks the stone-fruits, such as the peach, plum, and cherry, and sometimes the apple and pear. Its first effect is to induce a brown discoloration of the fruit accompanied by a copious production of ash-colored, dusty tufts on the surface of the fruit; these tufts are the fruiting threads of the fungus. Later the fruit becomes shrunken and dry, and in this "mummified" condition may remain for a long time without decay. Not infrequently the whole fruit becomes encased in a layer of brownish dust consisting almost entirely of the spores of the fungus.

Treatment.

The most practical method of checking the spread of the disease is by burning all diseased or "mummified" fruit. It is in this dried fruit that the fungus threads pass the winter. With the advent of warm weather the threads produce spores in immense quantities upon the remains of the fruit, and the fresh crop of fruit becomes readily infected. Hand-picking and burning all diseased fruit, both on the tree and on the ground, is therefore the surest method of combating the disease. It occasionally attacks both the leaves and twigs as well as the fruit, and in such a case again the best remedy is picking and burning the diseased parts.

Merely as an adjunct to this method of dealing with "brown-rot," treatment of the trees and subjacent ground with the simple solution of copper sulphate as recommended for apple "scab," etc., would undoubtedly be of benefit. This treatment should be given during the last of March or the first part of April, and may be followed during the summer by applications of the ammonia solution of copper carbonate, or weak Bordeaux mixture.

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Note.

If Paris green in water is used upon plum-trees to prevent the destructive attacks of the curculio, the danger of burning the foliage can be avoided by adding lime to the insecticide, in the proportion of 1 lb. to 50 galls.

DISEASES OF THE GRAPE.

"BLACK-ROT." { *Phyllosticta Labruscæ*, Thüm. / *Phoma uvicola*, B. & C. / *Læstadia Bidwellii*, (Ell.) Viala & Ravaz.

This well known disease usually appears first upon the leaves and young shoots, producing reddish-brown or blackish spots. About two weeks later the berries are attacked, the first evidence of this being a black or brownish spot at one or more points on the surface. Soon the whole berry turns brown, then black, and finally becomes hard and leathery, while still remaining on the stalk. A magnifying glass reveals on the surface of the diseased berries minute black pimples, within which the several forms of spores produced by the fungus are borne.

Treatment.

Warm, damp weather is especially conducive to the spread of the disease, so that during such weather the vines will require constant care. The first precaution to be taken in the spring consists in ploughing or cultivating between the rows so as to turn under or cover any diseased grapes which may have fallen the previous year.

Treatment of the vines immediately after pruning, with the strong solution of sulphate of copper is advisable (p. 89); but more important is the summer spraying with the Bordeaux mixture.

Experiments conducted in 1891 by the U. S. Dep't of Agric. indicate that the Bordeaux mixture reduced to even one-sixth the usual strength (see Formula 2, p. 103, of this Report), is thoroughly effective against "black-rot," and of course the expense is much less.

If the Bordeaux mixture is used throughout the season there is danger of some of the dried copper compound remaining on the berries when harvested, and this damages the appearance of the ruit, though the quantity of copper is too small to produce any

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injurious effects from eating the grapes. This staining of the fruit may be remedied by using the ammoniacal carbonate of copper for the last two sprayings instead of the Bordeaux mixture.

Time of application.

Early treatment is indispensable to success. The appearance of the first leaves should be the signal to begin spraying. Make the first application then, repeat it just before the vines begin to bloom, follow it up with a third as soon as the vines have finished blooming, and repeat at intervals of twelve or fifteen days according to the weather, until the berries are half grown. The most critical period in this climate is about the last of June; the spraying at this time should therefore be especially thorough and careful. According to the experience of the Department of Agric., "six treatments, the last two after the grapes were practically grown, gave little better results than four, the last being made when the berries were the size of bird-shot." Of course the frequency of the applications must depend largely on the weather.

"Downy Mildew." [*Plasmopara viticola*, (B. & C.) Berl. & De Ton.]

The fungus producing this disease is more disastrous to the vines themselves than the fungus of "black-rot," inasmuch as it attacks the leaves, causing them to turn brown and fall prematurely. Later it may attack the berries. The latter do not dry and shrivel as in the case of "black-rot," but they assume a grayish tint, the surface becomes discolored in places especially near the stem end, and finally, decay accompanied by a uniform brown color destroys the fruit. On the leaves the disease is readily recognized by the grayish, downy, or furred appearance produced on the under surface of the leaves by the fruiting threads of the fungus. This downy form of the disease may also attack the berries, and under such circumstances is unmistakable.

Treatment.

The same treatment is to be recommended for the "downy mildew" as for "black-rot." If the vines are treated for the latter the same treatment will suffice for both diseases.

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"ANTHRACNOSE" (*Sphaceloma ampelinum*, DeBary).

This disease attacks the canes, leaves, and berries. On the leaves it produces small brownish spots with a slightly raised border. Later these spots become gray in the center and often separate from the surrounding healthy portions of the leaf, leaving the latter full of round ragged holes. On the canes the effect is similar except that the spots often become confluent, producing large elongated diseased areas of a grayish color and slightly flattened or depressed. On the berries the spots are more nearly circular, and their appearance, gray in the center with a reddish surrounding circle and a dark border, gives to the disease the common name of "bird's-eye rot."

Treatment.

The best remedy for "anthracnose" is to wash or spray the vines after pruning, and before the buds begin to swell in the spring, with a strong solution of sulphate of copper, using one pound to ten gallons of water. "Anthracnose" is not liable to do much damage in vineyards that are well treated for "mildew" or "black-rot," especially if the vines are severely trimmed.

DISEASES OF THE RASPBERRY AND BLACKBERRY.

"ANTHRACNOSE." (*Gloeosporium Venetum*, Speg.)

The "anthracnose" produces on the canes, small round or elongated whitish patches, slightly flattened and bordered with a ring of dark purple. These patches gradually increase in size and number, and finally destroy the new growth or stunt it badly. Upon the leaves it is often visible as very small yellowish spots surrounded by a dark border, resembling those on the canes but much smaller. The fungus producing the disease passes the winter in the diseased canes and leaves, a fresh crop of spores is produced from the old spots in the spring, and the new canes and foliage are readily infected.

Treatment.

As in the case of the grape "anthracnose," cutting out all diseased wood and burning it will gradually eradicate the disease. It should be cut out in winter or very early spring, below the lowest diseased spot. If the canes are then sprayed with a solu-

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tion of sulphate of copper, using one pound to twenty-five gallons of water, and if necessary sprayed two or three times during the summer with Bordeaux mixture, very little damage is to be feared from the "anthracnose."

DISEASES OF THE STRAWBERRY.

"Leaf-blight." (*Sphœrella Fragariæ*, Sacc.)

This disease is characterized by the appearance of reddish areas on the upper surface of the leaves. Later there appear in the center of these discolored areas gray or whitish spots, upon which in autumn and winter are developed several forms of the reproductive bodies or spores of the fungus which causes the discoloration of the leaf.

Treatment.

By annually renewing the settings, and planting only in deep and thoroughly drained soil, the loss from blight will be very largely diminished. Removing and destroying all the old leaves after harvesting, followed by cultivation, and the application of a quick fertilizer, is a process which has produced good results.

A more simple method which has been adopted with complete success by certain growers in this State, is as follows:—As soon as the berries are picked, run a mowing machine over the bed, cutting all the leaves close above the ground. As soon as the leaves and old mulch are dry enough, set fire to them and burn the bed over. If necessary, loosen up the old mulch a little with a fork before burning and put on more where it is scanty, in order to secure as even a burn as possible. Unless a severe drought follows, the plants soon put up a new, vigorous, and healthy growth; mulch as usual in the autumn. In a dry season this method must be used with caution, but if the burning is followed by rain, the process has in all cases proved a complete cure for the "leaf-blight."

DISEASES OF THE ONION.

"Smut." (*Urocystis Cepulæ*, Frost.)

This disease attacks the onion seedling, appearing as dark spots or lines in the leaves. Later, and as other leaves develop and become attacked, these spots begin to crack open longitudinally,

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exposing the fungus with its spores as a black, powdery mass. If the disease is not checked by the natural withering of the leaf first attacked, it spreads throughout the plant, affecting even the bulb, on which it produces black, linear elevations, running down to the base of the bulb and extending up into the leaves.

Treatment.

The only treatment, except rotation and transplanting, which has ever been recommended for onion "smut," is that suggested in the Reports of this Station for 1889 and 1890. It consists in sowing in the drill, with the seed, either a mixture of equal parts of sulphur and lime, or of sulphide of potassium and lime. The experiments which led to this suggestion were made on very smutty land, and increased the yield in a ratio of about 5 to 1. They were merely preliminary and therefore not decisive, but the result certainly seems to warrant a repetition of the experiment. The details will be found in the Reports referred to. It seems probable now that the measure of success attending this treatment will hardly warrant its very extended adoption, and that onion growers in this State, as elsewhere, will have to adopt the method of starting the plants from seed in cold frames, and transplanting to the field. This method is laborious, but the additional labor is compensated for by an earlier harvest, and very superior bulbs.

To lessen the danger of spreading the disease it should be noted that all implements used in smutty ground should be thoroughly washed before being used in clean ground; that all refuse left on the field from a crop infected with "smut," should be collected and burned; that when it is possible, onion land should be burned over in the fall; and that at the second and subsequent hand-weedings, all onions which show the "smut" should be pulled and burned at once.

DISEASES OF THE POTATO.

"MILDEW" OR "ROT." [*Phytophthora infestans*, (Mont.) DeBary.]

This disease first appears as a premature wilting of the tops of the vines. The color rapidly changes to yellow and then to a dirty brown. On the under side of the leaf in these diseased portions, is seen a delicate whitish mould, the fruiting threads of the

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fungus. The disease spreads quickly, inducing a very rapid and characteristic decay in the plants, and if not checked, the fungus causing the decay makes its way to the tubers and affects them, producing the well-known "rot."

Treatment.

If applied in time, the Bordeaux mixture is an effectual preventive of potato "rot." It should be applied whether the disease appears or not, since it is a preventive rather than a cure. If the potatoes have been affected in previous years, or if the attack is sudden and severe, Formula No. 1, p. 103, should be used.

Time of application.

The first application should be made when the plants are about half grown, and it should be repeated every ten or twelve days until the tops begin to wither. If it is desired at the same time to treat the vines for the "potato bug," Paris green may be used with the Bordeaux mixture by stirring the former to a smooth paste in water and adding it to the latter in the proportion of one pound of Paris green to 100 gallons of the mixture. As a rule, treatment for the "potato bug" will have to be begun much earlier than for the "rot." It may be more convenient however, and it can do no harm, to begin treatment with the combined fungicide and insecticide at the earlier date when the "potato bug" first appears. There is no doubt that potato vines derive from the treatment with Bordeaux mixture an increase of vitality beyond that due to the prevention of the "rot" alone, although it is not yet fully known to what characteristic of the Bordeaux mixture this beneficial action is due.

"Mould." (*Macrosporium Solani*, Ell. and Mart.)*

This fungus usually appears in connection with injuries to the leaves caused by the flea-beetle and other insects. Its most serious attacks are confined to early potatoes, and induce dead, blackened areas, usually beginning at the tips or edges of the leaves. The parts attacked soon die and become curled or shriveled. The fungus is confined to the tops, and does not directly affect the tubers.

* *Cf.* Vt. Agric. Exp't Station, Report for 1892, p. 66, *e. s.*

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Treatment.

This disease can probably be held in check by early applications of Bordeaux mixture, though results of definite experiments to this end are as yet wanting.

"SCAB." (*Oospora scabies*, Thaxter.)*

The eroded pits on the surface of potato-tubers, caused by the growth of this minute fungus, are too familiar to require any extended description here.

Treatment.†

Dissolve two ounces of corrosive sublimate (bichloride of mercury) in fifteen gallons of water. Immerse the seed potatoes in this solution for 1½ hours. Spread them out to dry, then cut and plant as usual.

Note.—Corrosive sublimate is a fatal poison if taken internally. It also corrodes metallic substances, and the solution should therefore be made in wooden vessels.

DISEASES OF THE TOMATO.

"MOULD." (*Cladosporium fulvum*, Cke.)

This fungus forms rusty-brown patches on the under side of the leaves, inducing a yellowing and wilting, usually followed by the death of the leaf attacked.

Treatment.

Inasmuch as warmth, moisture, and insufficient circulation of air are all factors in the spread of this disease, training the plants on sticks or trellises to keep them off the ground, and pruning away all the lower branches and leaves so as to allow of the free access of sun and air, will to a great degree prevent the disease. Should it still prove harmful however, either the Bordeaux mixture or the ammoniacal carbonate of copper will be found effective.

* *Cf.* Conn. Agric. Exp't Station, Report for 1890, p. 81, *e. s.*

† *Cf.* N. Dak. Agric. Exp't Station, Bull. 9, 1893, p. 32.

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"POTATO-ROT." [*Phytophthora infestans*, (Mont.) DeBary.]

This fungus which does so much damage to potatoes frequently attacks tomatoes also. Its general effect is the same in both cases, and it may be controlled by the same means.

DISEASES OF CELERY.

"LEAF-SPOT." (*Cercospora Apii*, Fres.)

This disease attacks the leaves of celery, forming upon them discolored spots and blotches. Sometimes almost the whole leaf becomes involved, the blotches presenting a more or less pale and watery appearance.

Treatment.

The ammoniacal solution of copper carbonate has been used with some success against this disease, but from our own experience we would recommend the use of sulphur. A warm, sunny day should be chosen, and the sulphur dusted upon the plants, at the rate of about 2 lbs. to 1200 plants for each application. The application should be made four times, at intervals of ten days or two weeks.

NOTE.—The treatment should be begun as soon as the disease makes its appearance. Great care should be exercised in selecting seedlings. Seedlings already affected with the disease are frequently offered for sale by retail dealers. Buy only from reliable, first-class seedsmen.

THE PREPARATION OF FUNGICIDES.

BORDEAUX MIXTURE.

Formula 1.

Sulphate of copper ("blue vitriol," "blue-stone")	2½ lbs. or 6 lbs.
Quick lime	2 lbs. or 4 lbs.
Water	22 galls. or 45 galls.

Formula 2.

Sulphate of copper	1 lb.
Quick lime	1 lb.
Water	22 galls.

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Pulverize the sulphate of copper and dissolve in 2 galls. of water heated to hasten the solution.* Dilute this solution with 14 galls. of water. Slake the lime (which should be fresh, i. e. not partly air-slaked) with 6 galls. of water, adding the latter slowly and stirring to a smooth cream. Allow this mixture to stand a short time, then stir it and pour it slowly into the copper sulphate solution, stirring rapidly during the operation. *Never pour in any of the coarser sediment which settles readily to the bottom.*

This mixture should be made fresh for each application in order to secure the best results.

Formula 2 is, of course, cheaper than Formula 1, and is quite as effective against "black-rot," and "mildew" of the grape, and "leaf-blight" of the tomato.

AMMONIACAL CARBONATE OF COPPER.

Carbonate of copper	5 oz.
Aqua ammonia (strong)	3 pts.
Water	45 galls.

Mix the carbonate of copper to a thick paste with water. Dissolve this paste with 3 pts. of ammonia, or if that is insufficient to dissolve all the carbonate, add a little more. Dilute with water to 45 galls.

The strong, undiluted solution may be made and kept in stock, to be diluted and used as needed.

The carbonate of copper can be made more cheaply than it can be bought by dissolving in one barrel 3½ lbs. of carbonate of soda (sal soda) in one gallon of hot water, and in another barrel 3 lbs. of sulphate of copper in two gallons of hot water. When the solutions are complete, and *cool*, pour the sal soda solution slowly into the copper solution, stirring continuously. A heavy green precipitate will result, consisting of carbonate of copper. Now fill the barrel up with water, let the carbonate settle at the bottom, and then siphon off the clear water. Repeat the operation once. Finally, strain out and dry the carbonate of copper, of which there will be found to be 1½ lbs.

Prepared in this way the copper carbonate will cost about 18 cents per pound.

* In case the larger proportions in formula 1, are used, double the amount of water must be used in each step of the preparation.

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MODIFIED EAU CÉLESTE.

Sulphate of copper ("blue-stone")	4 lbs.
Carbonate of soda	5 lbs.
Aqua ammonia (strong)	3 pts.
Water	50 galls.

Dissolve the sulphate of copper and the carbonate of soda in warm water in separate vessels. When completely dissolved and cool, mix the two, stirring continuously. Add the ammonia until a clear solution is obtained, and dilute with water to 25 gallons.

The solution can be made more adhesive and therefore more effective by the addition of 3 lbs. of soap dissolved in hot water, or 5 lbs. of molasses to every 25 galls. of the solution.

COST OF MATERIALS.

The following are the approximate wholesale prices of the chemicals most commonly used as fungicides.

Lime	per bbl.	(300 lbs.)	$ 1.65
Sulphate of copper (granulated)*	"	(450 lbs.)	18.00
Sulphate of iron	per lb.		.01
Carbonate of copper	"		.42
Carbonate of soda	"		.02
Sulphur (flowers of sulphur)	"		.02
Sulphide of potassium (liver of sulphur)	"	about	.12
Aqua ammonia (26°)	"		.08

SPRAYING APPARATUS.

PUMPS.

For spraying on a large scale where a large portable receptacle is needed, a strong force-pump which can be mounted on a barrel and drawn from place to place, is a great saving of time and labor. A pump well adapted to this purpose is "Gould's double-acting spraying pump" fitted with couplings on both sides which allows of the simultaneous use of two sets of hose, and the spraying of two orchard rows at the same time. This pump, which is powerful, simple, and compact, is made by the Gould M'f'g. Co., of Seneca Falls, N. Y. An equally good pump for use under the same conditions is manufactured by W. & B. Douglas, of Middle-

* The Nichols Chemical Company, 45–49 Cedar St., New York City.

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town, Conn. The mixture may be kept stirred by means of a disk of wood screwed to the end of a broom-handle and inserted through a hole in the top of the barrel.

For spraying on a smaller scale, or where a mounted barrel cannot be driven, some form of "knapsack" sprayer is convenient if not essential. Many forms are advertised, all made on the principle of combining with a small force-pump, a tank or receptacle to be carried on the back. A very perfect machine of the kind is known as the "Galloway Knapsack Sprayer." The Messrs. Douglas, of Middletown, are prepared to furnish this sprayer, or one very similar to it.

If the area to be sprayed requires but six or eight gallons of the liquid, as e. g. in greenhouse work, or when only a few plants or vines are to be treated, a most serviceable pump for attaching to a pail is the Johnson pump, sold for $4.50 by Cordley & Hayes, 173–175 Duane St., New York City. If the nozzle sent with this pump is removed and replaced by a piece of ⅜-in. hose, 6 or 8 ft. long, provided with a Vermorel nozzle, a most effective and convenient means of spraying on a small scale is procured.

Nozzles.

It is hardly necessary to say, after so much has been written and said on the subject, that for the proper application of fungicides a rose nozzle or an ordinary sprinkler is not sufficient. Several spraying nozzles have been devised of which only two need be mentioned here, the Nixon and the Vermorel.

In the Nixon nozzle the liquid is driven through a fine gauze cap and issues in a copious, smoky spray. For use with clear liquids it is unsurpassed. With mixtures however, like the Bordeaux mixture which contains lime in suspension, this nozzle is liable to clog and is not readily cleaned.*

The Vermorel nozzle works equally well with clear solutions and with liquids having substances in suspension, it delivers a fine and abundant spray, and is on the whole the most serviceable nozzle for general work with which we are acquainted.

A very useful adaptation of the Vermorel nozzle, called an "Undersprayer," is manufactured and sold by Messrs. Wm. Boekel & Co., 518 Vine St., Philadelphia, Pa. The nozzle is

* This nozzle may be procured of the Nixon Nozzle and Machine Co. of Dayton, Ohio, at $1.00 each.

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attached to a brass pipe, 3 ft. long, by a union-joint, which allows of its being turned and the spray applied directly upwards or in any required direction. It is of special use in spraying grape-vines for "mildew." The advertised price of the "Undersprayer" is $1.75.

Hose.

It is often necessary in directing a spray at some distance from the ground, to use a greater length of hose than would ordinarily suffice. The best kind for the purpose, as for any light discharge pipe, is what is known as ¼-in. or ½-in. "linen insertion tubing." The hose should be attached to a light pole of sufficient length to reach above the foliage to be sprayed, so that the spray may be directed downwards upon it. A simple means of accomplishing this is to tie the nozzle and the end of the hose carrying it, to a stick a foot or so long which is riveted or screwed to the end of the pole in such a way as to turn parallel to the plane of the pole. Thus the nozzle can be directed either downwards or upwards as desired.

The following quotations for spraying pumps and accessories are furnished by Messrs. W. & B. Douglas of Middletown, Conn. The quotations are on goods ordered directly from their factories at Middletown, and the prices are *net:*

Double-acting Spraying Pump (similar to Gould's) with all brass piston and brass outer cylinder*	$9.50
——— Double-acting Spraying Pump (similar to Gould's) with all brass piston and iron outer cylinder, fitted with leather valves	5.00
——— The same, fitted with metallic valves	6.50
Three feet suction hose for same with couplings and brass strainer	2.25
Single couplings for ¼-inch hose	.25
Y-coupling " "	1.00
Vermorel Nozzle (2 caps with coupling for ¼-inch hose or with large standard coupling as desired)	1.25
The Messrs. Douglas will also be prepared to furnish Prof. Galloway's Knapsack Spraying Pump with planished copper tank and copper cover, for about	11.00

Quotations for tubing given by the Goodyear Rubber Store, F. C. Tuttle, prop., 866 Chapel St., New Haven.

* For use with the copper compounds it is advisable to have all the parts of the pump, including the outer cylinder, made of brass, as these compounds corrode iron.

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¼-inch linen insertion tubing (lots of 100 feet or more) per foot	.08
" " " " (lots of 50 feet or more) per foot	.10
" " " " (lots of less than 50 feet) per foot	.12
¼-inch heavy rubber tubing, per foot	.18

A PROVISIONAL SPRAYING CALENDAR.

The following provisional calendar is given here at the request of several fruit-growers. It is manifestly impossible to give with any degree of accuracy the exact dates upon which fungicides should be applied. The fact that we sprayed last year on certain dates, by no means presupposes that those dates will be suitable the coming season.

Seasonal variations between two successive years, and the varying conditions of rain-fall from one season to another, are often so great that the exact date of any farm operation cannot be known beforehand. The following table is therefore merely approximate, to be modified by the exercise of common-sense.

January and February.

But little can be done during these mid-winter months in the way of spraying, though a great deal by way of preparation. If it has not been already done at the proper time, cut out and burn the "black knot" of plum and cherry now, and destroy all neighboring wild cherries which are knotty.

In the latter part of February do all necessary trimming of vines and fruit trees, unless this has been done in the autumn, as is often the case. Where "anthracnose" has previously attacked grape-vines, raspberries, or blackberries, prune severely, cut out every trace of diseased wood or cane and burn it. The increased vigor obtained by the free access of light, air, and ventilation will compensate for the severe pruning.

In open winters, February is none too early to go over the orchard carefully and collect and burn all leaves and fruit from diseased trees, such as mummified cherries, plums and peaches, scabby or rotted pears and quinces, and all blighted leaves. Remember that on the first warm day the air will be full of the germs of plant disease from these fruits and leaves, if they are not destroyed. Do not use them for bedding or mulch, and do not throw them into the pig-pen.

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March.

The middle or end of this month will see everything ready for winter treatment (copper sulphate, 1 lb. to 25 galls. of water). Select a warm day, or if possible, several days of warm, melting weather. In some seasons winter treatment can hardly be made before April. This treatment is especially good for diseases of apple, pear and quince, for "anthracnose," and for the "black-rot" of grapes. Where the latter has occurred the previous year, ploughing between the rows in order to cover up diseased berries will be found of great advantage. If plums and cherries suffer in summer from lice, spray the trees now with kerosene emulsion to destroy the eggs.

April.

Put all spraying apparatus in thorough order. Clean and rinse pumps, oil all bearings, see that the valves work well, and test the tubing for leaks.

If the winter treatment has been deferred until this month, see that it is finished before the middle of the month.

May.

This is usually the flowering month for vines and fruit trees, and the first application of Bordeaux mixture or other fungicide should immediately precede the opening of the flowers. Use your own judgment. Apples and pears are generally in bloom by the second week in May; quinces and grapes usually not until somewhat later. The importance of these early treatments can hardly be overestimated. Watch to see when the petals begin to fall, and make a second application within a few days after that date.

During the last part of May examine carefully the plum and cherry trees. The young "black-knots," now of a greenish color, will be found bursting through the bark. Cut them out and burn them, and paint the wound over at once. A day spent on the "black-knot" in May and June is worth ten days' work later.

June.

The first part of June usually marks the fall of the flowers of most fruit trees. Never spray while trees and vines are in full bloom. Make the second application as soon as the petals have

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fallen. This will be late in May or early in June for apples, a week or ten days later for other fruit-trees and grapes. Make the June treatment thorough. In spraying for apple-scab, add Paris green to the fungicide for this second application, and also for the third; this will act against the codling-moth. June is a critical month for all fruits and vegetables, especially for grapes. They are most susceptible to "black-rot" between June 20th and July 10th; treat thoroughly and frequently.

The spraying of potatoes should be begun this month; early in the month if the "mould" has been prevalent in former years, later if the "rot" alone is to be feared.

A good general rule to follow after the second spraying, is to let each additional treatment be made from ten days to three weeks after the preceding one; the shorter interval if there are heavy, washing rains, the longer if the weather is comparatively dry.

It must also be remembered that the more adhesive a fungicide is (e. g. the Bordeaux mixture), the less frequently will the applications be needed.

July.

This month will close the treatment for most diseases. To avoid the spotting of grapes by the Bordeaux mixture, the two applications during the latter part of this month should consist of the ammoniacal solution of copper carbonate. Early in the month spray for the "black-rot" of quinces, and continue treatment every two weeks until the last of August.

Continue the treatment of potatoes throughout this month and the following.

August.

The spraying season closes this month. For "leaf-blight" of strawberries, mow the leaves late in July or early in August, and after allowing them to dry where they lie, set fire to them and burn the bed over.

Thoroughly clean and oil all spraying apparatus, and see that it is carefully stored.

September, October, and November.

The months of harvest. When picking fruit, let one or two boys follow and clean the trees of all diseased and mummified

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fruit, collecting it in baskets to burn. At the same time gather and burn, as far as possible, all diseased fruit which has fallen.

In November clean the orchard thoroughly of fallen leaves, especially if disease has been prevalent, and burn them. Better to destroy them now than in the spring, when the fungous fruit will have come to maturity in and on the leaves.

December.

The "black-knot" fungus matures during December and January; attack it early in the former month. Use the pruning-knife unsparingly, cutting out two or three inches above and below each "knot." Burn every "knot," and paint the wound over at once.

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EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS. SEASON OF 1892.

FINAL REPORT ON THE FERMENTED CROPS OF 1892-3.

On pages one to twenty-four of the report for 1892, is given an account of the organization of the Connecticut Tobacco Experiment Company, of a general plan of experiments to test the effect of fertilizers on tobacco, to be carried out by this Station and the Tobacco Experiment Company jointly, of the raising, sorting and casing of the first experimental crop, and of the judgment of the experts on its appearance at the time when it was put in cases for fermentation. The cases lay in the public warehouse of Mr. B. L. Haas of Hartford, and were undisturbed till September 2d, 1893, when examination of the other crops there in store showed that fermentation was satisfactorily finished.

On the 2d of September, 1893, the cases of experiment tobacco were opened in the presence of a Station officer, samples were drawn from each lot of the wrappers by Mr. James McCormick, and these were immediately sealed in the usual manner, marked and left in charge of Mr. Haas. Duplicate samples, four "hands" in each, were taken for the Station.

Following are the weights of the cases as noted by the Station officer:

The letters designating the lots correspond with those in the published report of last year which has been already referred to. The weights, gross, tare and net, are in pounds avoirdupois.

Lots.	Case.	Gross.	Tare.	Net.
H. D. G.	No. 1	333	75	258
Q. C. F.	" 2	341	85	256
J. K. L.	" 3	347	85	262
X. S. O. P.	" 4	338	84	254
W. N. M. R.	" 5	342	85	257
V. U. E. A.	" 6	350	84	266
I. T. B.	" 7	357	82	275

SHRINKAGE OF THE TOBACCO DURING FERMENTATION.

A comparison of the figures given above, with those on page 11 of the last Station report, shows that the cases lost from 12.4 to 15 per cent. of their weight during fermentation, and that the average loss was 13.8 per cent.

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Quality of the Crops.

Messrs. William Westphal, Jr., David Rothschild, and Benjamin L. Haas, all of Hartford, Conn., served as judges of the Tobacco. These experts are engaged in the Connecticut leaf-tobacco trade, with the demands of which they are fully acquainted and two of them are practical cigar makers. They were not informed which plots were represented by the different lots of tobacco under examination, and the marks had been so changed as to make it impossible for them to determine this. They were requested to make a strict judgment, noting every defect in the quality, however slight. Hence the casual reader might gather from their report a more unfavorable opinion of the whole crop than it deserves. They devoted an entire day to the work, each making his own independent judgment which was then modified when necessary, by conference. How thorough the examination was will be seen by their report which follows.

It is believed that in this way there has been secured a perfectly unbiased and intelligent judgment on the quality of the crops, by dealers who are in touch with the present requirements of the Connecticut wrapper leaf trade.

The following schedule, prepared by Mr. B. L. Haas, was used by the judges as a guide in examining the leaves. It shows the special points which should be regarded in examining critically a crop of tobacco.

Diseases and Faults.	Ripeness.	Stem.
Is it flea-bitten?	Is it ripe?	Is it light?
worm-eaten?	over-ripe?	medium?
hail-cut?	under-ripe?	heavy?
torn?		
musty?	Size of Leaf.	Taste.
	Is it very desirable?	Is it strong?
Has it pole-burn?	desirable?	mild?
white vein?	medium?	bitter?
white mould?	large?	
	vein-cutter?	Texture of Leaf.
Character of Vein.		Is it extra-fine?
	Color of Leaf.	fine?
Is it prominent?	Is it cinnamon?	silky?
fine?	dark yellow?	pimply?
woody?	light yellow?	mottled?
green?	dark brown?	gummy?
white?	black?	brittle?
curly?	green?	harsh?
	spotted?	dead?

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BURN OF THE LEAF.

Is it slow?	Quality of the ash—Is it firm?
free?	flaky?
Does it hold fire long?	Color of the Ash—Is it clear white?
fairly?	blue white?
short time?	muddy?
not at all?	gray?
Does it coal not at all?	black?
somewhat?	black and white?
badly?	mixed?

Number of Leaves in one pound .....

In order to facilitate comparison, there is prefixed to the judges' report on the quality of each lot of tobacco, the name of the plot, the fertilizers applied per acre and their cost, together with the quantities of nitrogen, phosphoric acid and potash which each supplied, and the yield of pole-cured long and short wrappers per acre.

REPORT OF THE JUDGES.

LOT A.

Fertilizers: 1500 lbs. cotton seed meal, 1500 lbs. cotton hull ash per acre, containing 105 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $50.25.

Yield: 770 lbs. long wrappers per acre.
350 " short " "
Total 1120 "

Quality:—*Burn*, good, holds fire very well. *Ash*, light gray. *Vein*, thin and good. *Texture*, good. *Size*, good and desirable. *Ripeness*, ripe. *Colors*, dark red and mottled. *Yield*,* very good. *Soundness*, very sound. *Taste*, good. *Stem*, medium. *Remarks*, desirable.

LOT B.

Fertilizers: 2000 lbs. cotton seed meal and 1500 lbs. cotton hull ash per acre, containing 140 lbs. nitrogen, 165 lbs. phosphoric acid, 350 lbs. potash. Costing $57.25.

Yield: 715 lbs. long wrappers per acre.
415 " short " "
Total 1130 "

* "Yield" here means not the number, size, or weight of leaves but the number of *cut wrappers* the crop can furnish.

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Quality:—*Burn*, somewhat slow, coals. *Ash*, mixed gray, flakes slightly. *Vein*, small and perfect. *Texture*, medium glassy and close grain. *Size*, medium and desirable. *Ripeness*, ripe. *Color*, light to medium, clear and glassy. *Yield*, profitable. *Defects*, slightly worm-eaten. *Taste*, good. *Stem*, medium. *Remarks*, fair style.

LOT C.

Fertilizers: 2500 lbs cotton seed meal and 1500 lbs. cotton hull ash per acre, containing 175 lbs. nitrogen, 180 lbs. phosphoric acid, 359 lbs. potash. Cost $63.75.

Yield: 855 lbs. long wrappers per acre.
340 " short " "
Total 1195 "

Quality:—*Burn*, free, inclined to coal slightly. *Ash*, clear gray, hard. *Vein*, small and very fine. *Texture*, open grain. *Size*, very desirable. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, immense. *Soundness*, sound. *Taste*, good. *Stem*, small and fine. *Remarks*, very desirable.

LOT D.

Fertilizers: 3000 lbs. cotton seed meal and 1500 lbs. cotton hull ash per acre, containing 210 lbs. nitrogen, 195 lbs. phosphoric acid, 368 lbs. potash. Cost $70.50.

Yield: 1085 lbs. long wrappers per acre.
300 " short " "
Total 1385 "

Quality:—*Burn*, free, holds fire, slightly inclined to coal. *Ash*, very hard and white. *Vein*, very small and fine. *Texture*, open grain. *Size*, very desirable. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, very good. *Soundness*, sound. *Taste*, good. *Stem*, small. *Remarks*, very desirable.

LOT E.

Fertilizers: 1980 lbs. castor pomace and 1500 lbs. cotton hull ash per acre, containing 105 lbs. nitrogen, 139 lbs. phosphoric acid, 334 lbs. potash. Cost $50.79.

Yield: 735 lbs. long wrappers per acre.
375 " short " "
Total 1110 "

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Quality:—*Burn*, fair, holds fire fairly well. *Ash*, light gray, flakes some. *Vein*, heavy, curly. *Texture*, medium. *Size*, medium. *Ripeness*, ripe. *Color*, medium to dark. *Yield*, medium. *Soundness*, very sound. *Taste*, good. *Stem*, heavy. *Remarks*, undesirable.

LOT F.

Fertilizers: 2640 lbs. castor pomace and 1500 lbs. cotton hull ash per acre, containing 140 lbs. nitrogen, 150 lbs. phosphoric acid, 340 lbs. potash. Cost $57.72.

Yield: 760 lbs. long wrappers per acre.
420 " short " "
Total 1180 "

Quality:—*Burn*, good, coals slighty, burns free. *Ash*, white and hard. *Vein*, small and fine, but little curl. *Texture*, open grain. *Size*, medium size. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, only fair. *Soundness*, fairly sound. *Taste*, good. *Stem*, small and fine. *Remarks*, fairly desirable.

LOT G.

Fertilizers: 3300 lbs. castor pomace and 1500 lbs. cotton hull ash per acre, containing 175 lbs. nitrogen, 161 lbs. phosphoric acid, 347 lbs. potash. Cost $64.65.

Yield: 895 lbs. long wrappers per acre.
275 " short " "
Total 1170 "

Quality:—*Burn*, coals slightly, fairly free. *Ash*, mixed gray but hard. *Vein*, small and fine. *Texture*, open grain, very thin. *Size*, little above the medium. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, very good. *Soundness*, very sound. *Taste*, good. *Stem*, small and fine. *Remarks*, desirable.

LOT H.

Fertilizers: 4000 lbs. castor pomace and 1500 lbs. cotton hull ash per acre, containing 212 lbs. nitrogen, 173 lbs. phosphoric acid, 354 lbs. potash. Cost $72.00.

Yield: 1110 lbs. long wrappers per acre.
330 " short " "
Total 1440 "

Quality:—*Burn*, very free, but inclined to coal, holds fire well. *Ash*, clear gray and hard. *Vein*, small and medium. *Texture*,

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open grain. *Size*, fair, but inclined to be large. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, fair to good. *Soundness*, sound. *Taste*, good. *Stem*, small and fine. *Remarks*, desirable.

LOT. I.

Fertilizers: 2640 lbs. castor pomace, 1500 lbs. cotton hull ashes and 440 lbs. nitrate of soda per acre,* containing 210 lbs. nitrogen, 150 lbs. phosphoric acid, 340 lbs. potash.

Yield: 1060 lbs. long wrappers per acre.
390 " short " "
Total 1450 "

Quality:—*Burn*, good and holds fire. *Ash*, clear, grayish. *Vein*, coarse, prominent. *Texture*, coarse, but good grain. *Size*, too large. *Ripeness*, ripe. *Colors*, mottled and reddish. *Yield*, poor. *Soundness*, sound. *Taste*, good. *Stem*, coarse. *Remarks*, undesirable.

LOT J.

Fertilizers: 2640 lbs. castor pomace, 1500 lbs. cotton hull ashes and 440 lbs. nitrate of soda † per acre, containing 210 lbs. nitrogen, 150 lbs. phosphoric acid, 340 lbs. potash. Cost $68.72.

Yield: 1280 lbs. long wrappers per acre.
340 " short " "
Total 1620 "

Quality:—*Burn*, good and holds fire well. *Ash*, white and does not flake. *Vein*, coarse, prominent, curly. *Texture*, coarse. *Size*, medium and undesirable. *Ripeness*, ripe. *Color*, uneven, mottled and medium. *Yield*, poor. *Soundness*, fairly sound. *Taste*, very good. *Stem*, coarse. *Remarks*, undesirable.

LOT K.

Fertilizers: 1500 lbs. cotton seed meal, 1220 lbs. double sulphate of potash and magnesia and 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $43.95.

Yield: 955 lbs. long wrappers per acre.
415 " short " "
Total 1370 "

Quality:—*Burn*, slow, inclined to coal, holds fire fairly. *Ash*, clear gray and hard. *Vein*, very small and fine. *Texture*, A

* 220 lbs. applied at time of first cultivation and 220 lbs. at second cultivation.
† Applied between rows at time of first cultivation.

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No. 1. *Size*, very desirable. *Ripeness*, ripe. *Colors*, medium to light. *Yield*, very good. *Soundness*, very sound. *Taste*, good. *Stem*, light. *Remarks*, very desirable except burn.

LOT L.

Fertilizers: 1500 lbs. cotton seed meal, 1220 lbs. double sulphate of potash and magnesia, 360 lbs. Cooper's bone and 300 lbs. lime per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $44.70.

Yield: 965 lbs. long wrappers per acre.
455 " short " "
Total 1420 "

Quality:—*Burn*, very free. *Ash*, clear white, does not flake. *Vein*, inclined to curl. *Texture*, open grain. *Size*, good. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, very fair. *Soundness*, very sound. *Taste*, good. *Stem*, small and fine. *Remarks*, fairly desirable.

LOT M.

Fertilizers: 1500 lbs. cotton seed meal, 620 lbs. high grade sulphate of potash and 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $42.70.

Yield: 835 lbs. long wrappers per acre.
355 " short " "
Total 1190 "

Quality:—*Burn*, poor and coals, does not hold fire. *Ash*, dirty gray. *Vein*, good. *Texture*, close grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium to dark mottled. *Yield*, good. *Soundness*, very sound. *Taste*, bitter. *Stem*, small and fine. *Remarks*, undesirable.

LOT N.

Fertilizers: 1500 lbs. cotton seed meal, 620 lbs. high grade sulphate of potash, 360 lbs. Cooper's bone and 300 lbs. of lime per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $43.45.

Yield: 745 lbs. long wrappers per acre.
305 " short " "
Total 1050 "

Quality:—*Burn*, coals, does not hold fire. *Ash*, white. *Vein*, very good. *Texture*, good. *Size*, good and desirable. *Colors*, light, but somewhat mottled. *Yield*, very good indeed. *Sound-*

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ness, very sound. *Taste*, good. *Stem*, small and fine. *Remarks*, very desirable, except fire-holding quality.

LOT O.

Fertilizers: 1500 lbs. cotton seed meal, 580 lbs. carbonate of potash and 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 341 lbs. potash. Cost $74.95.*

Yield: 625 lbs. long wrappers per acre.
245 " short " "
Total 870 "

Quality:—*Burn*, very free, inclined to coal, but holds fire well. *Ash*, clear gray, hard. *Vein*, very small and fine. *Texture*, A No. 1. *Size*, perfect, small. *Ripeness*, ripe. *Colors*, very light and desirable. *Yield*, immense. *Soundness*, great. *Taste*, good. *Stem*, very fine. *Remarks*, very desirable except burn.

LOT P.

Fertilizers: 760 lbs. nitrate of potash, 500 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 146 lbs. phosphoric acid, 341 lbs. potash. Cost $66.47.†

Yield: 315 lbs. long wrappers per acre.
140 " short " "
Total 455 "

Quality:—*Burn*, slow, inclined to coal, holds fire well. *Ash*, clear gray, hard, does not flake. *Vein*, very small and fine. *Texture*, papery. *Size*, very desirable. *Ripeness*, ripe. *Colors*, light and desirable. *Yield*, immense. *Soundness*, very sound. *Taste*, good. *Stem*, very small and fine. *Remarks*, not very desirable.

LOT Q.

Fertilizers: 2020 lbs. Baker's AA superphosphate and 3920 lbs. Baker's Tobacco Manure per acre, containing 230 lbs. nitrogen, 466 lbs. phosphoric acid, 510 lbs. potash.

Yield: 1275 lbs. long wrappers per acre.
450 " short " "
Total 1725 "

* If carbonate of potash, not chemically pure, were bought in ton lots, the cost would be much less.

† Nitrate of potash, not chemically pure, bought in ton lots, would make the cost considerably less.

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Quality:—*Burn*, slow burn, *coals* slightly, does not hold fire long. *Ash*, clear white, flakes slightly. *Vein*, prominent and curly. *Texture*, open grain. *Size*, too large. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, not profitable. *Soundness*, perfectly sound. *Taste*, good. *Stem*, heavy. *Remarks*, not desirable.

LOT R.

Fertilizers: 2000 lbs. Stockbridge Tobacco Manure per acre, containing 99 lbs. nitrogen, 207 lbs. phosphoric acid, 126 lbs. potash.

Yield:	725 lbs.	long wrappers per acre.
	375 "	short " "
Total	1100 "	

Quality:—*Burn*, inclined to coal. *Ash*, clear gray. *Vein*, fine and small. *Texture*, good, open grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium and mottled. *Yield*, very good. *Soundness*, very sound. *Taste*, good. *Stem*, small and fine. *Remarks*, fairly desirable.

LOT S.

Fertilizers: 4000 lbs. Stockbridge Tobacco Manure per acre, containing 219 lbs. nitrogen, 278 lbs. phosphoric acid, 391 lbs. potash.

Yield:	1120 lbs.	long wrappers per acre.
	415 "	short " "
Total	1535 "	

Quality:—*Burn*, slow burn, inclined to coal, does not hold fire long. *Ash*, clear gray. *Vein*, fine and small. *Texture*, good open grain. *Size*, medium to large. *Ripeness*, ripe. *Colors*, medium to dark. *Yield*, profitable. *Soundness*, very sound. *Stem*, medium. *Remarks*, desirable with exception of burn.

LOT T.

Fertilizers: 900 lbs. Ellsworth's Starter and 2700 lbs. Ellsworth's Foundation per acre, containing 215 lbs. nitrogen, 238 lbs. phosphoric acid, 168 lbs. potash.

Yield:	1170 lbs.	long wrappers per acre.
	335 "	short " "
Total	1505 "	

Quality:—*Burn*, good and holds fire well. *Ash*, white and does not flake. *Vein*, good. *Texture*, coarse and fleshy. *Size*,

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medium. *Ripeness*, not quite ripe. *Color*, red and mottled. *Yield*, good. *Soundness*, perfectly sound. *Taste*, good. *Stem*, prominent. *Remarks*, undesirable.

LOT U.

Fertilizers: 501 lbs. lime, 501 lbs. Mapes Starter, 2601 lbs. Mapes Tobacco Manure W. B. per acre, containing 173 lbs. nitrogen, 230 lbs. phosphoric acid, 312 lbs. potash.

Yield: 1290 lbs. long wrappers per acre.
390 " short " "
Total 1680 "

Quality:—*Burn*, does not hold fire. *Ash*, white, flakes slightly. *Vein*, curly and heavy. *Texture*, medium grain. *Size*, too large. *Ripeness*, ripe. *Color*, medium to dark. *Yield*, unprofitable. *Soundness*, very sound. *Taste*, good. *Stem*, very heavy. *Remarks*, not desirable.

LOT V.

Fertilizers: 501 lbs. lime, 501 lbs. Mapes Starter, 2601 lbs. Mapes Tobacco Manure, special, per acre, containing 170 lbs. nitrogen, 205 lbs. phosphoric acid, 418 lbs. potash.

Yield: 890 lbs. long wrappers per acre.
285 " short " "
Total 1175 "

Quality:—*Burn*, slow, holds fire fairly well. *Ash*, white. *Vein*, curly. *Texture*, thick and oily, medium grain. *Size*, too large. *Ripeness*, ripe. *Color*, medium to dark. *Yield*, unprofitable. *Soundness*, very sound. *Taste*, fair. *Stem*, coarse. *Remarks*, not desirable.

LOT W.

Fertilizers: 501 lbs. lime, 501 lbs. Mapes Starter, 2601 lbs. Mapes Tobacco Manure, special, per acre, containing 176 lbs. nitrogen, 227 lbs. phosphoric acid, 364 lbs. potash.

Yield: 875 lbs. long wrappers per acre.
285 " short " "
Total 1160 "

Quality:—*Burn*, slow, holds fire fairly well. *Ash*, clear gray and solid. *Vein*, somewhat prominent. *Texture*, medium, close grain. *Size*, medium. *Ripeness*, inclined to be unripe. *Color*,

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greenish cast, running to mottled and medium colors. *Yield*, profitable. *Soundness*, sound. *Taste*, bitter. *Stem*, medium. *Remarks*, not desirable.

LOT X.

Fertilizers: 6080 lbs. of L. Sanderson's Formula B per acre, containing 345 lbs. nitrogen, 581 lbs. phosphoric acid, 643 lbs. potash.

Yield: 970 lbs. long wrappers per acre.
325 " short " "
Total 1295 "

Quality:—*Burn*, slow burning, does not hold fire well, coals. *Ash*, a very dirty gray. *Vein*, small, perfect. *Texture*, medium, open grain. *Size*, medium and desirable. *Ripeness*, ripe. *Color*, medium and mottled. *Yield*, profitable. *Soundness*, sound. *Taste*, somewhat bitter. *Stem*, medium. *Remarks*, undesirable lot.

The lots in order of their value as wrappers, taking all points into consideration, were arranged by the judges as follows, the most valuable coming first, in the table, and the least valuable last.

O (best),	C,	D,	G,	H,	K,	N,	F,
1st	2d	3d	4th	5th	6th	7th	8th

L,	A,	S,	B,	R,	P,	Q,	E,
9th	10th	11th	12th	13th	14th	15th	16th

T,	W,	I,	U,	X,	J,	M,	V (poorest).
17th	18th	19th	20th	21st	22d	23d	24th

DISCUSSION OF THE QUALITY OF THE CROPS.

It is designed to repeat the experiments with fertilizers here referred to, and fully described in the Report of last year, for a period of at least five years. By this means the effects of differences of season may be noted, the cumulative effect of the different fertilizers may be studied, and misapprehensions corrected which might arise in the deductions from the results obtained in any single year. It is well therefore to use caution in interpreting these first results which may be considerably modified by subsequent experiments in years less favorable to the growth of the crop.

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It will be noticed that there are only four or five lots of tobacco which are perfectly satisfactory as regards their burning quality. The defect in some cases is very slight, and not enough to seriously lower the market values. It is also noted by the judges that all the tobacco has a very slight abnormal feeling in the hand, best described perhaps, as a rawness, or want of finish. The defect in burning quality, or slight tendency to coal, common to nearly all the lots, as well as the rawness, are attributed to the fact that the crop was raised on new ground which had not been planted to tobacco for many years, nor even been under good cultivation for a long time. It may be expected that in subsequent crops these defects will disappear.

Comparison of the Crops, before and after Fermentation.

In our report on the unfermented crops, it was said: "It must be distinctly understood that this judgment is given on the appearance of the unfermented leaves, and it is expressly stated by the experts to be in no sense a final judgment on the quality of the crop.

The relative value of the tobacco from the several plots is liable to very great changes during the fermentation which no one can appreciate or estimate from an examination of the tobacco before it has been cased and fermented."

The comparison of the judgments of the quality of the different lots before and after fermentation, will illustrate the truth of this statement.

Of the seven lots of unfermented leaves named as best before fermentation, five are among the seven best after fermentation, but lot A, which ranked first before fermentation, ranks tenth now, and lot I, that stood second then, is now classed as nineteenth, among the poorest.

Lot V, judged the poorest before fermentation, is judged the same after fermentation, but the other five lots which were judged poorest then, are not among the five poorest now. Lot B, which ranked twenty-third before, now ranks as twelfth.

These illustrations make clear the wisdom of the plan adopted to carry the tobacco through the fermentation and not to give a final judgment on its quality till it came out of the case.

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Comparative Fire-Holding Capacity.

The experts tested each sample with reference to fire-holding capacity in ways usual in the trade. A more elaborate test was afterwards made at the Station, using 10 leaves (5 short wrappers and 5 long wrappers), and testing each leaf at 6 different places, 3 on each side of the midrib, at the base, near the center, and near the tip. The average of these 60 tests is taken to represent the fire-holding capacity of the lot. The details of the operation are given in the Report for 1892, page 17, and need not here be repeated.

The lot which held fire for the shortest time is marked 100, and the other lots are marked so as to represent numerically their comparative capacity for holding fire; for example, of the long wrappers, lot Q held fire for a shorter time than any other; lot A held fire between 4 and 5 times as long, lot P more than 8 times as long.

Comparative Fire-Holding Capacity.

	Long Wrappers.	Short Wrappers.	Calculated from the mean of both.	Average number of seconds during which leaf holds fire. Unfermented.	Fermented.
A	485	222	310	9	26
B	464	675	552	10	47
C	398	331	336	13	29
D	309	296	282	11	24
E	357	227	263	8	23
F	383	1086	746	18	64
G	309	219	240	11	21
H	482	226	311	10	27
I	234	222	213	10	18
J	252	261	241	11	21
K	325	208	240	9	21
L	320	352	317	10	27
M	270	315	278	7	24
N	225	215	205	8	18
O	285	319	286	11	25
P	822	509	599	16	52
Q	100	112	100	6	9
R	257	213	217	10	19
S	185	161	160	9	14
T	187	154	157	7	14
U	165	109	124	7	11
V	451	100	230	8	20
W	263	133	163	5	15
X	178	196	176	6	15

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The fire-holding capacity is an important element in the value of the leaf, but is not in itself a decisive quality. Inspection of the table shows that of the 12 lots which had the average, or more than the average fire-holding capacity, 10 were judged by the experts to be of average, or above average quality and value as wrappers.

The table also shows the average number of seconds during which the leaves held fire both before and after fermentation. It appears that all the lots without exception were improved in their fire-holding capacity by fermentation, though by no means in the same degree; thus lot U, before fermentation held fire 7 seconds; after fermentation 11 seconds, a gain of about one-half, while lot M, before fermentation held fire the same length of time, 7 seconds, but after fermentation, 24 seconds, or more than 3 times as long. The average fire-holding capacity of all the lots before fermentation was 9.6 seconds, after fermentation 24.4 seconds.

Effect of Larger Quantities of Nitrogen than are Commonly used and Comparison of Cotton Seed Meal and Castor Pomace as Fertilizers.

These two subjects are conveniently examined together. There is little difference in the yield of crops raised with help of the two fertilizers when applied in corresponding quantities. Lots A, B, C, D, raised with cotton seed meal and cotton hull ashes, yielded at the rate of 1207 pounds of wrappers per acre. Lots E, F, G, H, raised on castor pomace in equivalent quantity, and cotton hull ashes, yielded 1225 pounds of wrappers.

Nor is there any important difference in the *quality* of the four crops raised on these two fertilizers. The lots raised on cotton seed meal, ranked 2nd, 3rd, 10th and 12th, while those on castor pomace, ranked 4th, 5th, 8th and 16th.

There is, however, a difference in each case in both quality and quantity when crops raised by use of large *quantities* of meal or pomace are compared to crops produced with small applications. The total yield of crop increased with the increase of either fertilizer, being very decidedly the largest, when 3000 pounds of cotton seed meal, or its equivalent, 4000 pounds of pomace were used. The yields of wrapper leaves were as follows :

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A (1500 Cotton Seed Meal), 1120 lbs. wrappers.
B (2000 " "), 1130 " "
C (2500 " "), 1195 " "
D (3000 " "), 1385 " "
E (1980 Castor Pomace), 1110 lbs. wrappers.
F (2640 "), 1180 " "
G (3300 "), 1170 " "
H (4000 "), 1440 " "

This increase has not been attended by loss of quality in the leaf; on the contrary, the wrappers raised with the two larger applications of meal or pomace, are judged by the experts to have a distinctly better quality, than those grown with the smaller applications. The lots which received the heavier applications, rank 2nd, 3rd, 4th and 5th, those that had lighter applications rank 8th, 10th, 12th and 16th.

In what respects the increased quantity of these fertilizers has improved the quality of the crops is seen by an inspection of the expert's report. There is no perceptible difference in the burn, the ash is perhaps a little firmer, the texture is better, the colors are lighter, and the stems smaller.

The soil on which the tobacco was raised was at the outset in low condition. It is quite possible that after the land has been brought into good heart, applications of these maximum quantities of cotton seed meal or of castor pomace continued year after year may have no distinctly favorable effect on either quality or quantity of crop, or may even prove injurious.

Effect of Applications of Nitrate of Soda, at the First and Second Cultivation.

The point of this experiment, plots H, I, J, is to ascertain the effect on the crop of supplying one-third of the nitrogen of a heavy application (210 pounds), as a top dressing in the form of nitrate of soda in one application at the time of the first cultivation (Plot I) or in two applications at the time of the first and second cultivation (Plot J). This year the effect has been decidedly injurious. The burn was not impaired, but the veins were coarse and curly, stem coarse, and colors uneven and mottled. The wrappers raised on 4000 pounds of castor pomace with cotton hull ashes (H) rank 5th. The wrappers raised on 2640 pounds of castor pomace, and 440 pounds of nitrate, ranked 19th and 22nd, that is among the very poorest, though in one case, lot J, they weighed more than those of lot H by 180 pounds.

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There was no striking difference in the effect of nitrate of soda whether used in a single application at the time of first cultivation (J) or in two applications at the first and second cultivation, I.

The Effects of Potash from Various Sources.

The results of these tests are difficult to understand, and it is unwise to try to draw any definite conclusions from them till corroborated by those of following years.

For example, the wrappers of M, raised on high grade Sulphate, which is regarded as a particularly safe form of potash for tobacco, were among the very poorest of the whole lot, having a bad burn, dirty gray ash, medium to dark colors, close grain and bitter taste. Yet the same application of high grade Sulphate, with the addition of 300 pounds of lime (lot N) gave a somewhat smaller crop of wrappers, of good quality, ranking 7th in the list. Their burn was defective, and the colors somewhat mottled, but otherwise the wrappers were unobjectionable.

The double manure salt by itself (K), and also with added lime (L) gave a considerably larger crop than any other form of potash, and also an excellent quality of wrappers, somewhat better indeed than the same quantity of cotton hull ashes. The leaves from K and L ranked 6th and 9th in quality. In this case the added lime had no marked effect on the quality of the crop.

Carbonate of potash, Lot O, yielded only a very small crop, 870 pounds of wrappers per acre. The yield was possibly depressed by the caustic action of the carbonate, but the quality was pronounced by the judges to be the very best of all.

Nitrate of potash, Lot P, yielded an extremely small crop, only 450 pounds of wrappers, and the quality was below the average. It should be said, however, that a tremendous rain just after planting may have carried a large part of the nitrogen of this plot, which was entirely in the form of nitrate, down out of the reach of the crop, so that the small yield and inferior quality may be due to deficiency of nitrogen, and not to any unfavorable action of the nitrate. This seems to be a reasonable explanation.

Comment on the lots raised with fertilizers supplied by the different fertilizer manufacturers, is reserved to await further results. This year the wrappers raised with these fertilizers, while above the average yield of the other plots have been as a rule below the average quality. It should be remembered that these tests are in no sense a competitive trial of various brands, but are in the nature of experiments by the manufacturers to test the value of certain mixtures.

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EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS. SEASON OF 1893.

The following experiments are in continuation of those begun last year by this Station, in coöperation with the Connecticut Tobacco Experiment Co., of Poquonock, and described in the Report of this Station for 1892, pages one to twenty-four.

Plan of the Experiments.

Four points regarding the effect of fertilizers on tobacco, were contemplated in the work of last year. They were the following:

1. What is the effect on quantity and quality of leaf of larger applications of cotton seed meal than are commonly used as a fertilizer? (Plots A, C, D.)

2. What is the comparative effect on quantity and quality of leaf, of applications of castor pomace containing the same amounts of nitrogen as the cotton seed meal used in the experiments under 1? (Plots E, G, H, compared with A, C, D.)

3. If a heavy application of nitrogen in the form of castor pomace proves injurious to the leaf, can the injury be lessened or prevented if half of this quantity of nitrogen is supplied by castor pomace and the other half by nitrate of soda? (Plots I, J, compared with A, E.)

4. What are the comparative effects on quantity and quality of leaf, of applications of equal quantities of potash (K_2O) in the following forms: Cotton hull ashes, high grade sulphate of potash, the same with lime, double sulphate of potash and magnesia, the same with lime, pure carbonate of potash, and pure nitrate of potash? (Plots K, L, M, N, O,* compared with A.)

Early in 1893 the Tobacco Experiment Co. purchased additional land and extended the scope of the experiments to cover the following points:

5. What is the effect on quantity and quality of leaf, of applications of linseed meal containing the same quantity of nitrogen as the cotton seed meal and castor pomace used in the other experiments? (Plot B, compared with Plots A and E. Notice also F and CC.)

* The comparison of nitrate of potash was discontinued this year on account of the very small yield and small per cent. of wrappers obtained last year.

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6. What is the effect on quantity and quality of leaf, of using less than half the quantity of cotton hull ashes or about 150 pounds of actual potash to the acre, instead of 340 pounds as in the other experiments? (Compare F and B.)

7. What is the effect on quantity and quality of leaf, of using fish as a source of nitrogen in place of cotton seed meal or castor pomace? (Compare Z and K; also notice T. The mixture on plot T was put in at the last moment to fill a vacancy made by the withdrawal from the experiment, of a manufacturer.)

8. What is the effect on quantity and quality of leaf, of using stable manure as a fertilizer by itself, or with "Swift-sure superphosphate" as a starter?* (Plot AA.)

9. What is the effect on quantity and quality of leaf, of using tobacco stems with castor pomace, both together and also with some superphosphate added as a starter? (Plot BB.)

Also under 4, unleached Canada ashes (Plot Y), and a new potash salt, the double carbonate of potash and magnesia (Plot P), which was described in the Report for 1892, page 34, are compared with the other forms of potash (Plots K, L, M, N, O and A).

On much smaller plots, containing about $\frac{1}{100}$ of an acre, tobacco was grown with the three fertilizing ingredients, nitrogen, phosphoric acid, and potash, each by itself and in the different combinations possible with these ingredients. (Plot DD.)

The Experiment Field.

The experiments of last year were repeated in every case on the same plots as before.

The new plots, of precisely the same shape and size, ($\frac{1}{20}$ acre), as those used in 1892, were in the same field, and by the side of the others, and were marked Y, Z, AA, BB, CC, DD. These new plots are on ground believed to be like the rest of the field in texture and quality, with the exception that the new land had not been cultivated for six years, and was covered with a neglected growth of poverty grass and blackberry vines. It was in the same condition as the tobacco field of last year before it was taken up for the experiments of 1892.

* A "starter" is a soluble and quickly acting fertilizer which is put in the row where the plants are to be set, intended to meet the immediate wants of the young plants before the broadcast fertilizer becomes available.

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Fertilizers.

The stalks of last year's tobacco crops were put back on the plots from which they came, and were ploughed under very early in the spring. The fertilizers applied (1893) with the exception of the nitrate of soda, cotton seed meal, high grade sulphate of potash and double manure salt, were all sampled and analyzed by the Station. The raw materials contain the following percentages of nitrogen, phosphoric acid and potash:

Composition and Cost of Fertilizers Used.

	Cost per ton.	Nitrogen.	Phosphoric Acid.	Potash.
Nitrate of Soda	$52.50	16.00	....	....
Cotton Seed Meal	32.00	7.00	3.00	1.80
Castor Pomace	25.00	4.64	1.45	1.09
Linseed Meal	27.00*	5.98	1.90	1.40
Tobacco Stems	14.00	1.92	.60	8.10
Cooper's Bone	27.00	1.60	29.20	....
Cotton Hull Ashes	44.00	....	6.33	19.04
Wood Ashes	12.00	....	1.00	5.60
High Grade Sulphate	55.00	....	....	50 60
Carbonate of Potash	170.00†	....	....	54.10
Double Carbonate Potash and Magnesia	39.00‡	....	....	18.10
Double Manure Salt	30 00	....	....	26.00
Fish	45.00	8.06	6.70	....

The mixed fertilizers supplied by certain manufacturers were also weighed, sampled and analyzed by the Station with the following results: The samples of Baker's Tobacco Manure and AA. Phosphate were lost by an accident, after the fertilizers had been sown. They were claimed to have the average composition of these brands and therefore the analyses of these goods as found in the Connecticut market the last season are inserted in the table.

* Given to the Station by the Cleveland Linseed Oil Co. for the experiment.

† By the single pound. Ton rates for an article not chemically pure, would be very much lower.

‡ Total cost of importing a one ton lot from Stassfurt. The quantity used in the experiments was given to the Station by the Stassfurt Potash Syndicate.

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ANALYSES OF MIXED FERTILIZERS USED IN THE EXPERIMENT.

	Baker's Tobacco Manure.	Baker's AA. Phosphate.	Stockbridge's Tobacco Manure.	Mapes' Tobacco Manure, Wrapper Brand.	Mapes' Tobacco Starter.	Sanderson's Formula for Tobacco.	Pinney's Formula for Tobacco.	Shoemaker's Swift Sure Superphosphate.
Station No.	**3951**	**3889**	**4021**	**4020**	**4024**	**4022**	**4023**	**3837**
Plots	Q.	Q.	R. & S.	U.V.W.	U.V.W.	X.	C.C.	A.A.B.B.
Nitrogen as nitrates		.23	3.23	1.26	.51	trace	....	.66
" as ammonia	3.92	2.01	....	2.46	.45	3.08	....	....
" organic	.47	.61	2.87	2.22	1.83	2.09	4.63	2.23
Total nitrogen	4.40	2.85	6.10	5.94	2.79	5.17	4.63	2.89
Total phosphoric acid	5.28	12.22	9.80	5.97	12.51	14.07	7.01	14.39
Total potash	11.70	3.21	12.08	10.85	3.33	5.27	7.47	4.72
Chlorine	.79	3.23	1.55	.57	.45	.26	.23	....

The quantities of chemicals for each plot were accurately weighed by the Station representative, mixed thoroughly under his supervision, and bagged and labeled by him.

The bags were carried to the several plots by Mr. DuBon and their contents were sowed on the plots by him or under his constant supervision.

All the fertilizers were very carefully and evenly sown when no wind was blowing. The plots were immediately harrowed by Mr. DuBon, each by itself, to avoid carrying fertilizer from one plot to the next. The "starters" were applied later, in the usual way. The whole piece was then "rowed out," the rows running east and west.

The following statement shows what fertilizers were put on each plot, their cost and the quantities of nitrogen, phosphoric acid and potash contained in them, expressed in pounds per acre:

FERTILIZERS APPLIED, 1893.

Most of the plots which were under experiment in 1892 received the same fertilizers in 1893 as in the previous year. Where a change was made however, in 1893, it is indicated by italics.

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Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds.		
			Nitrogen.	Phosphoric Acid.	Potash.
A	1500 Cotton Seed Meal 1660 Cotton Hull Ashes	$60.35	105	150	342
B	1760 *Linseed Meal* 1660 *Cotton Hull Ashes*	57.79	105	138	340
C	2500 Cotton Seed Meal 1540 Cotton Hull Ashes	73.88	175	172	342
D	3000 Cotton Seed Meal 1500 Cotton Hull Ashes	81.00	210	184	342
E	2260 Castor Pomace 1660 Cotton Hull Ashes	64.60	105	139	340
F	1760 *Linseed Meal* 660 *Cotton Hull Ashes* 260 *Cooper's Bone*	41.79	105	150	150
G	3760 Castor Pomace 1560 Cotton Hull Ashes	81.32	175	154	342
H	4520 Castor Pomace 1520 Cotton Hull Ashes	89.94	210	164	342
I	2260 Castor Pomace 1660 Cotton Hull Ashes 328 Nitrate Soda* 328 " " †	81.96	210	139	340
J	2260 Castor Pomace 1660 Cotton Hull Ashes 656 Nitrate Soda*	81.96	210	139	340
K	1500 Cotton Seed Meal 1220 Double Manure Salt 360 Cooper's Bone	47.12	110	150	342
L	1500 Cotton Seed Meal 1220 Double Manure Salt 360 Cooper's Bone and 300 Lime	47.94	110	150	342
M	1500 Cotton Seed Meal 620 High Grade Sulphate of Potash 360 Cooper's Bone	45.87	110	150	340

* Applied between rows at time of first cultivation.

† Applied between rows at time of second cultivation.

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Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds. Nitrogen.	Phosphoric Acid.	Potash.
N	1500 Cotton Seed Meal 620 High Grade Sulphate of Potash 360 Cooper's Bone and 300 Lime	46.69	110	150	340
O	1500 Cotton Seed Meal 580 Carbonate of Potash 360 Cooper's Bone	78.12*	110	150	342
P	1500 *Cotton Seed Meal* 1740 *Double Carbonate Potash and Magnesia* 360 *Cooper's Bone*	62.75*	110	150	342
Q	2000 Baker's A. A. Superphosphate 4000 " Tobacco Manure	----	233	456	533
R	2000 *Stockbridge Tobacco Manure* 500 " " " †	---	153	245	302
S	3000 *Stockbridge Tobacco Manure* 500 *Stockbridge Tobacco Manure*†	----	214	343	403
T	880 *Dry Fish* 440 *Nitrate of Soda* 720 *Cooper's Bone* 300 *Lime*	42.05	153	268	none.
U‡	600 *Mapes' Starter* 2200 " *Tobacco Manure W. B.*	----	147	206	259
V‡	800 *Mapes' Starter* 2000 " *Tobacco Manure W. B.*	----	141	220	244
W‡	1000 *Mapes' Starter* 1800 " *Tobacco Manure W. B.*	----	135	232	229
X	2000 *Sanderson's Formula*	----	103	281	105

* If bought in ton lots, not chemically pure the cost would be considerably less.

† Applied as a starter.

‡ These plots have an area of $\frac{1}{10}$ acre each.

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The following plots were planted for the first time in 1893 :

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds.		
			Nitrogen.	Phosphoric Acid.	Potash.
Y	1500 Cotton Seed Meal 5620 Unleached Wood Ashes 160 Cooper's Bone	$59.74	105	153	342
Z	1300 Dry Fish 1220 Double Manure Salt 200 Cooper's Bone	52.12	105	147	342
AA	Stable Manure 10–12 cords* On half the plot Swift Sure Superphosphate at rate of 500 per acre	....	126	143	172
BB	6000 Tobacco Stems and 2640 Castor Pomace On half the plot Swift Sure Superphosphate at rate of 500 per acre	84.80	252	146	538
CC	Pinney's Formula†	....	139	210	224
DD 1	No fertilizer of any kind	....	....	....	....
DD 2	1520 Castor Pomace	....	71	22	17
DD 3	1440 Cooper's Bone	....	23	420	....
DD 4	1760 Double Carbonate Potash and Magnesia	....	....	....	319
DD 5	1520 Castor Pomace 1760 Double Carbonate Potash and Magnesia	....	71	22	336
DD 6	1440 Cooper's Bone 1760 Double Carbonate Potash and Magnesia	....	23	420	319
DD 7	1520 Castor Pomace 1440 Cooper's Bone 1760 Double Carbonate Potash and Magnesia	....	94	442	336
DD 8	No fertilizer of any kind	....	....	....	....

*Estimated to contain 111 lbs. nitrogen, 71 lbs. phosphoric acid and 149 lbs. potash.

†The nitrogen of this formula is chiefly in the form of linseed meal.

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The Plants and the Planting.

The plants were of the so-called "Havana seed" from seed grown by Mr. DuBon. The rows were 3½ feet apart, eight rows in a plot, and the plants were accurately set 17 inches apart, making about 8,700 to the acre. The plants were set out by Mr. DuBon and his men on June 8th.

Notes during the Growing Season.

Following is Mr. DuBon's record, kept during the time that the crop was growing.

June 8th: Planted the whole piece to-day.

June 25th: Up to this date about 4,000 plants had to be reset on account of injury from cut-worms.

July 3d: H and D have a very uneven stand, on account of the ravages of worms and the dry weather. The plants on R and S are also very uneven, R more so than S. The season has thus far been very dry. The stand on U, V, and W is very uneven; U is the best of the three. V and W are the poorest plots in appearance on the whole field on account of the attacks of worms, and the dry weather. Plots AA, BB, CC and Z have the most even stand, these plots having been treated with Paris green the day after planting. It was feared that these new plots would be more subject to the attacks of worms than the others because they were on new ground; so Paris green was applied to the new plots and not to the others. All the other plots on the field look about equal.

On this day, 32 pounds of nitrate of soda were applied to plot J, and half that quantity to plot I.

July 10th: The effect of the nitrate of soda was favorable to the strong plants, but a few of the re-set plants, that were small, were checked in their growth and some of them died. I believe it is best to use nitrate of soda after the plants are a foot high to get the best results. Plots A, E, I, J, T, O, CC, Q, Y, AA and BB are the most uniform and most forward. Plots R, S, U, V and W are the most uneven. The rest of the field looks about alike. The plants on the half of the plots AA and BB, where swift-sure superphosphate was applied are about one-third larger than on the other half.

July 19th: W, very uneven, poorest of all, V next, U up to the average of the field. B looks sick and poor, G up to the

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average of the field, much better than B. Plots O, P, Q and Z above the average on the old part of the field. H and D are quite alike, and uneven. G, C, F and B are good, CC good and the stand very even. BB good, very even and best on the half where swift-sure starter was applied. AA good and very even and the half where swift-sure starter was applied is the best of all the field. Plots I and J, improved only a very little by the application of nitrate of soda. DD1 is of a pale green color, and the smallest of all. The other seven are about alike, and nearly as large as the rest of the field, but a paler green.

July 26th: 16 pounds of nitrate of soda, applied to plot I. Plots A, E, I, J, T, very good, although the weather is very dry; also N, M, K, L, O, P, Q, Z; very little difference in these plots. H, D, C and G look somewhat better. CC, Z and T, are above the average for evenness. Commenced topping to-day. BB and AA are nearly all topped on the half where swift-sure starter was applied, being ahead of all the rest of the field. U, V, and W are behind all the rest.

August 16th: Finished topping. Of the plots U, V and W, U is the best and W the poorest.

August 19th and 20th: A very light rain has come at last and continued until the 20th in the afternoon and has wet the ground three inches down. This is more rain than we have had at any one time since the 8th of June when the plants were set. The tobacco has been pinched through all the growing season until now.

August 24th: A driving storm has broken the tobacco somewhat, but the heavy rain has improved it very much. Plot AA was affected most by the dry weather, and plot CC, next. All the rest of the field has stood the drought well.

August 28th: Plants on T, U and X are the largest at this date, and on the rest of the field are quite even in size. The larger part of the tobacco is ripe now but must stand another week, on account of the re-set plants which are growing. There is a marked difference between T and Z in favor of T, as it looks in the field. T is fresh and growing, while Z is about ripe and not so large.

August 30th: Commenced harvesting to-day.

September 1st: Finished the harvesting. The weather has been clear, or slightly overcast, and the crop was secured in good shape.

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NOTES ON TEMPERATURE AND RAINFALL, SEASON OF 1893.

1893 was the coldest year since 1888, though June, August and September were not colder than usual.

For the tobacco-growing months the average, maximum and minimum temperatures were as follows:

	Average.	Maximum.	Minimum.
June	67.5	92	48
July	69.8	89	49
August	69.7	88	45

The normal rainfall in Windsor is 45.60 inches. In 1893 it was only 41.42 inches or 4.18 inches below normal. All the summer months were much drier than usual.

The rainfall was 1.75 inches in June, 1.68 in July and 2.74 in August, the larger part of the August fall being in the latter part of the month, when there were two very violent wind and rain storms within a single week. This rain was a great help to the crop, but the leaves were very badly torn and beaten down by the wind in some places.

The average temperature and the total rainfall is given by weeks in the following statement. The figures are kindly furnished by Mr. Harry Moore of Windsor.

Fractions of a degree have been omitted in the statement of temperature.

	1892.		1893.	
	Average Temperature.	Total Rainfall.	Average Temperature.	Total Rainfall.
Week ending June 8	71	.05	69	.53
" " " 15	67	3.94	68	.15
" " " 22	73	1.07	70	.01
" " " 29	71	.64	64	1.06
" " July 5	68	1.68	67	.14
" " " 12	69	.45	68	.81
" " " 19	70	.51	71	.38
" " " 26	75	.96	69	.04
" " Aug. 2	74	1.38	69	.33
" " " 9	73	2.76	70	.13
" " " 16	71	1.15	70	.20
" " " 23	70	.09	66	.78
" " " 30	64	1.33	73	1.61

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Harvesting, Curing, Stripping and Sorting.

On the 30th of August and 1st of September all the tobacco was harvested. Each lath on which stalks were strung was marked with the letter denoting the plot and the whole number of laths for each plot was counted.

The laths were so hung in the barn that an equal portion of the tobacco from each plot was hung in the purline bent and in each of the other lower bents.

The crop cured without any appearance of pole-burn and hung in the barn till December 25th, when it was taken down and carted to Mr. DuBon's barn where it lay in the basement till January 2d, 1894. On the second and third of January it was taken from the laths and stripped from the stalks, bundled and weighed.

Each lath was examined to prevent possible mixture of crops from different plots and the laths from each plot were in every case counted. The numbers agreed exactly with those of the counting at harvest time.

Sorting was begun by Mr. DuBon on the 5th of January and finished on the 12th. All the weighings during the sorting were made by the Station representative.

As the crop was sorted samples were carefully drawn from each lot of long and short wrappers. Each sample contained twelve "hands," (15 to 20 leaves in each "hand"). Four "hands" were tied together by the butts and a tag was attached bearing a number which designated the plot.

These samples, each consisting of three bunches, four hands in each bunch, were taken to the warehouse of Mr. L. B. Haas, of Hartford, where they were cased for fermentation, the case being lined with top leaves and seconds from the same crop.

The remainder of the crop was sold.

No attempt was made to judge of the quality of the wrappers before they were fermented as the experience of last year showed that such a judgment was likely to be reversed by an examination of the crops after fermentation.

The results of the sorting and of some preliminary examinations of the quality of the tobacco are here given together, followed by discussion of the results.

The following table gives the results of the sorting. The weights are in pounds. For those unfamiliar with the details of

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sorting leaf-tobacco, it may be said that the "seconds" are the lower leaves on the stalk, smaller than those of either of the other grades, over-ripe and unfit for wrappers. The "long wrappers" and "short wrappers" are the most valuable part of the crop, the latter being smaller and lighter, and often cutting to greater advantage than "long wrappers." The "top leaves" are often as large as the long wrappers, but heavier, darker in color and unripe.

WEIGHTS OF THE BARN-CURED LEAVES FROM $\frac{1}{10}$ ACRE.

CROP OF 1893.

Plot.	Gross Weight of Leaves.	Long Wrappers.	Short Wrappers.	Top Leaves.	Seconds.	Waste and Shrinkage.	Net Weight of Sorted Tobacco.
A	80	26½	8	21½	15½	9	71
B	78	29½	9½	20½	14½	4½	73½
C	80½	23⅝	8½	25½	18	4⅝	75⅝
D	83	26⅝	9½	24½	19⅝	2⅝	80½
E	85½	30½	9½	26½	15⅝	4½	81
F	84½	36½	9½	19⅝	14½	5	79½
G	80	21½	11	29½	16½	2	78
H	87½	34½	10½	17½	21½	3½	84
I	86	33½	9½	22½	15½	5½	80½
J	91½	40½	13	20½	13⅝	4	87½
K	92½	37½	9½	21	19½	5½	87½
L	80½	25⅝	9½	23½	19½	3	77½
M	85	22⅝	9⅝	27½	20⅝	4½	80½
N	87½	29½	12	27	17	2	85½
O	78	21⅝	10	29½	13½	3½	74½
P	72½	24	11⅝	22	11½	3½	69½
Q	100½	42½	10	23½	19½	5	95½
R	78½	22⅝	8½	25⅝	18½	3½	75½
S	89½	30⅝	10⅝	25⅝	17⅝	4½	85
T	95	36⅝	9	28⅝	18½	2½	92⅝
U*	103½	48⅝	12½	20½	20	2	101½
V*	84	34½	9	17⅝	15½	7½	76⅝
W*	77½	30⅝	8½	17	18⅝	2½	74⅝
X	78½	26½	10	24½	15½	2½	76
Y	79½	18	6½	24½	25⅝	4⅝	74⅝
Z	73½	15⅝	7½	24	17⅝	8½	65
AA	69½	13½	12⅝	21½	18⅝	3	66½
BB	74	15	9	27½	16½	6	68
CC	69½	8⅝	7⅝	25½	15½	12½	57½
DD	51						

* Reckoned to $\frac{1}{10}$ acre.

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PER CENT OF THE FOUR DIFFERENT GRADES.

POLE-CURED CROP OF 1893.

Plot.	Long Wrappers.	Short Wrappers.	Total Per cent. of Wrappers.	Tops.	Seconds.
A	37	11.3	48.3	29.9	21.8
B	39.9	12.9	52.8	27.5	19.7
C	31.3	11.2	42.5	33.7	23.8
D	33.4	11.5	44.9	30.5	24.6
E	37.3	11.4	48.7	32.4	18.9
F	45.7	11.6	57.3	24.8	17.9
G	27.3	14.1	41.4	37.8	20.8
H	41.1	12.5	53.6	20.8	25.6
I	41.6	11.5	53.1	27.9	19.0
J	46.0	14.9	60.9	23.4	15.7
K	42.9	10.9	53.8	24.1	22.1
L	33.2	11.9	45.1	30.0	24.9
M	28.2	12.1	40.3	33.9	25.8
N	34.5	14.0	48.5	31.6	19.9
O	29.1	13.5	42.6	39.6	17.8
P	34.6	17.1	51.7	31.7	16.6
Q	44.5	10.5	55.0	24.6	20.4
R	30.2	10.9	41.1	34.3	24.6
S	36.2	12.7	48.9	30.2	20.9
T	39.6	9.7	49.3	30.9	19.8
U	48.1	12.2	60.3	20.0	19.7
V	45.1	11.8	56 9	23.0	20.1
W	41.2	11.1	52.3	22.6	25.1
X	34.5	13.2	47.7	31.9	20.4
Y	24.1	8.8	32.9	32.6	34.5
Z	24.2	11.5	35.7	37.0	27.3
AA	20.3	19.2	40.5	32.3	28.2
BB	22.1	13.2	35.3	40.4	24.3
CC	15.3	13.6	28.9	44.5	26.6

DD not sorted on account of its inferior value.

COMPARATIVE FIRE-HOLDING CAPACITY.

POLE-CURED CROP OF 1893.

The method of determining fire-holding capacity is fully described in the Report of this Station for 1892, page 17.

The lot which held fire for the shortest time is marked 100 in the table and the others are marked higher and according to their

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relative fire-holding capacity. Thus lot Z is marked 100 as it had a lower fire-holding capacity than any other. Lot F, long wrappers, marked 180 held fire 1.8 times as long as Z.

	Long Wrappers.	Short Wrappers.	Calculated from the Mean of both.
A	213	238	227
B	298	273	283
C	230	180	200
D	171	188	181
E	149	189	172
F	180	261	227
G	275	187	224
H	224	190	204
I	169	242	211
J	193	256	229
K	173	147	160
L	139	148	145
M	149	156	152
N	172	143	155
O	166	168	167
P	290	215	247
Q	147	118	130
R	161	165	146
S	173	164	168
T	135	157	147
U	154	172	166
V	159	161	146
W	168	157	162
X	173	161	152
Y	138	200	172
Z	100	100	100
AA	169	193	183
BB	160	160	160
CC	176	136	152

NUMBER OF POLE-CURED LEAVES TO THE POUND.

CROP OF 1893.

	Long Wrappers.	Short Wrappers.
A	68	86
B	66	82
C	59	76
D	68	82
E	59	70
F	62	84
G	60	76
H	65	78
I	62	79

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	Long Wrappers.	Short Wrappers.
J	68	80
K	60	81
L	57	75
M	61	73
N	67	76
O	70	82
P	67	91
Q	54	68
R	61	73
S	66	81
T	60	76
U	52	73
V	58	72
W	70	85
X	66	72
Y	67	82
Z	68	71
AA	63	76
BB	71	82
CC	63	79

Discussion of the Results.

Net Weight of the Sorted Crops, 1893.

In 1892 there was harvested from 23 plots, of $\frac{1}{10}$ acre each, 2122 pounds of sorted tobacco, or at the rate of 1845 pounds per acre.

In 1893 there was harvested from 28 plots, 2183 pounds, or at the rate of 1559 pounds per acre. This is 84½ per cent. of the crop of 1892. The crop of 1892 contained 66.7 per cent. of wrappers. The crop of 1893 contains only 48.5 per cent.

The reduced yield in 1893 was caused in small part by the ravages of cut-worms, just after setting, which made the crop uneven, but was mainly due to the severe drought that prevailed through most of the growing season. The tobacco which was planted on plots Y, Z, AA, BB, CC, and DD, that had not been under cultivation for ten years, suffered more severely from drought than the crops on plots which had been under cultivation for a year.

On a single plot, U, the crop weighed at the rate of over 2000 pounds per acre, 2030 pounds, with 1225 pounds of wrappers. On plot Q the yield was 1910 pounds, with 1050 pounds of wrappers. These two plots bore more than any others in both years.

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Plot T followed next with 1855 pounds, and plots J, K, N and S all yielded between 1700 and 1750 pounds per acre.

Cotton-Seed Meal and Castor Pomace. The three plots on which cotton seed meal was used with cotton hull ashes alone averaged 1513 pounds of sorted tobacco per acre, those on which corresponding quantities of castor pomace were used with ashes alone, averaged 1620 pounds. In 1892 there was nearly the same difference of yield between these two sets of plots.

In 1892, however, the quantity of wrappers per acre from the plots that received castor pomace was only 17 pounds greater than the quantity from the corresponding plots where cotton-seed meal was used. But in 1893 97 pounds more of wrappers per acre were raised on castor pomace than on cotton seed meal.

Increasing the quantities of cotton seed meal increased the weight of crop. With castor pomace the increase was slight.

Nitrate of Soda with Castor Pomace. Where for an application of 210 pounds of nitrogen in castor pomace as on plot H, was substituted half that quantity of nitrogen in pomace and the other half in nitrate of soda, plots I and J, the yield was 70 pounds less per acre when the nitrate was applied, half at the first and half at the second cultivation, plot I; but the total yield was increased by 70 pounds per acre when the nitrate was all put on at the first cultivation, and the quantity of wrappers was increased by 165 pounds per acre. The relative yields on plot J as compared with H are not very different from those of the previous year.

Potash Salts. Of the various potash salts, the double sulphate of potash and magnesia (plot K), produced the largest total crop, 1745 pounds, and the largest quantity of wrappers, 940 pounds.

The high-grade sulphate of potash used with lime (plot N), came next in total yield, 1710 pounds, 825 pounds of wrappers, and the high-grade sulphate used without lime ranked third, 1610 pounds, though the quantity of wrappers from this plot was smaller than from most of the other plots on which potash salts were tested, 650 pounds. In 1892 plots M and N also produced more total crop and more wrappers than any of the potash-test plots except K, but in that year M yielded more than N.

All of the forms of potash which were compared with cotton-hull ashes this year gave a higher yield than the latter, excepting the new potash salt, the double carbonate of potash and magnesia.

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The quantities of wrappers, however, raised with either Canada ashes, Y (new land), carbonate of potash, O, or high grade sulphate of potash, M, were smaller than the weight of wrappers raised on cotton-hull ashes, A.

Linseed Meal. A comparison of the yield of plots B and F, to which linseed meal was applied, with plots A and E which received equivalent quantities of cotton seed meal and castor pomace shows that linseed meal yielded fully as much total crop and wrapper leaves as either cotton seed or castor pomace. Plot CC cannot be compared with the others being on new land which evidently suffered more from drought than that which had been under cultivation longer.

Smaller quantity of Potash. Plot B received, together with linseed meal, 340 pounds of actual potash per acre in form of cotton-hull ashes. Plot F received the same fertilizers in 1892 as B, but in 1893 had only 170 pounds of actual potash in form of cotton-hull ashes. The total crop in 1893 on F exceeded that on B by 120 pounds and the yield of wrappers by 135 pounds.

Very striking also is the result on plot T which received fish, nitrate of soda and bone in 1893, *with no potash at all.* Only two other plots yielded more tobacco than this one and there were only four plots out of the twenty-nine which yielded more wrappers.

Discussion of the crops raised on the new land is omitted because the drought affected them much more severely than the others.

Discussion of the fire-holding capacity and the number of leaves per pound may be deferred till the crop has been fermented.

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SOME OBSERVATIONS ON THE WORKING OF THE COOLEY SYSTEM AND THE DE LAVAL SEPARATOR SYSTEM IN COÖPERATIVE CREAMERIES.

The Cooley system of raising and measuring cream is sufficiently well known in this State to need no description. It may be said by way of explanation for the benefit of other readers who are unacquainted with it that the method consists in bringing milk warm from the cows into cans 8½ inches in diameter and 19 inches deep, holding 18 quarts and provided with a cover loosely fitting which allows free circulation of air but prevents any water from coming into the can when it is nearly filled with milk and submerged in water. The filled cans are submerged at once in pure water having a temperature of 45 degrees F. in summer and 40 in winter and remain at about the same temperature from 12 to 24 hours. Every can has a strip of glass set in near the bottom, on which are marked "spaces," each being $\frac{1}{64}$ of an inch in width. To draw off the cream the cans are lifted by hand or by an elevator; the skimmed milk is run off through a stop cock at the bottom till the lower limit of the cream layer corresponds with zero on the space scale. The number of "spaces" are then read off and recorded by the cream-gatherer who represents the creamery, and are credited on its books to the patron, who is paid by the number of "spaces" of cream furnished.

A "space" is the equivalent of a cylinder 8½ inches in diameter and $\frac{1}{64}$ inches high. The cream-gatherer collects daily or in some cases four times in the week the cream from all the patrons and carries it to the creamery to be ripened and churned.

The centrifugal separator system is more generally known. Under this system the warm milk is slowly run into a steel bowl which is made to revolve at high speed and by centrifugal force the heavier part of the milk is driven to the circumference of the bowl while the cream is forced to its center and by proper mechanical contrivance is constantly skimmed off as it accumulates and runs in a small stream into the cream-gathering vessel. In

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the same way the skim-milk is taken off nearer the circumference of the bowl and in a larger stream runs to the skim-milk tank.

When separator cream is sold to a creamery which runs mainly on the Cooley cream-gathering basis, it is usually paid for by the quart, the price depending on the quantity of butter got from a quart of separator cream in churning-tests made from time to time at the creamery.

Most of the creameries in this State are on the cream-gathering basis and the cream is raised by the Cooley system. A certain number of patrons of creameries as well as other dairymen, however, use and prefer the separator system.

In view of the rapid increase in the use of separators in this State and throughout the country the following questions are of great importance:

Is it possible to ripen and churn mixtures of cream raised by the two systems without greater loss of fat in buttermilk, than when the two are separately ripened and churned, and is the quality of the butter made from such a mixture as good as that of butter made from cream raised by either system, but ripened and churned by itself?

These questions were discussed at length in the meeting of the Dairymen's Association at Hartford in 1892, and while there was the widest difference of opinion, no one could offer a single accurate observation which had been made on the subject.

Later in the winter the Dairymen's Association, through its secretary, Mr. W. I. Bartholomew, of Putnam, asked the Station to make a study of these questions in the interest of dairymen and promised the coöperation of the Association.

The Station agreed to undertake this work and has up to the present time made the tests hereinafter described.

The analytical work was done at the Station laboratory in New Haven by Messrs. A. L. Winton and A. W. Ogden.

The tests were made at the Woodstock Creamery which was put at our disposal for the purpose by the Board of Directors.

Special acknowledgment is due to Mr. Abel Child, and to the superintendent, Mr. Hopkins, the butter maker at Woodstock Creamery for their cordial coöperation in the plan and for their skill and helpfulness which did much to make the experiments a success.

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1. COMPARISON OF THE CHURNING OF COOLEY CREAM, SEPARATOR CREAM AND A MIXTURE OF COOLEY AND SEPERATOR CREAM.

The plan first proposed was to weigh a batch of Cooley cream at the creamery as it was put into the churn, weigh the water and salt added in the butter making and also the buttermilk, washings and butter, and from the analyses of all these products determine just where each ingredient of the cream had gone. The same course was to be followed with a batch of Separator cream, and also with a batch of mixed Cooley and Separator cream.

The Creamery built for business purposes wholly, necessarily offers imperfect facilities for experiments of this kind, and makes the work of collecting and weighing the cream, the buttermilk and washings, extremely arduous while the chances of mechanical loss are large.

In later experiments the work was therefore limited to determining the total quantity of butter-fat which was in the cream and the quantity which was lost in buttermilk and washings.

Cooley Cream.

On March 6th the observations were begun with a lot of Cooley cream, which was received at the Creamery at 3.45 P. M. Its weight as received was 729⅛ pounds. Some of the cream was frozen, and after mixing in the ripening vat, the temperature of the whole was 40° F. It was immediately warmed so that at 5 P. M. the temperature was 70°. During the night it sunk to 66°, but was brought to 70° in the morning of March 7th, and held there till 10.30 when it was cooled for churning. At 1.30 P. M. the temperature was 63°, but rose one degree during the weighing as it was transferred to the churn. The weight of the cream as put into the churn was 730½ pounds, to which was added for rinsing the vat, 8⅝ pounds of water. After a few oscillations of the churn to mix thoroughly, the churn was stopped and one pound and one ounce was removed for laboratory sample, making the net weight of the cream churned, 738$\frac{1}{16}$ pounds.

The churning required 56 minutes and the butter came in fine granular condition. A small, weighed quantity of water was used to rinse down the sides and cover of the churn towards the

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end of the churning and this of course went in with the buttermilk. After the buttermilk was drained off, weighed and sampled, the butter in the churn was washed with a weighed quantity of water. This was then drawn off and in the following tabular statement is called "first washings." A smaller weighed quantity of water was next poured in to float the butter so that it could be conveniently removed from the churn. After the butter had all been taken out, this water was run off, weighed and sampled and is called for convenience the "second washings." On the weights of the butter and other milk products and their analyses the following calculations are based. The analyses are first given and next the calculations made from them.

ANALYSES OF THE COOLEY CREAM AND BY-PRODUCTS.

	Cooley Cream.†	Buttermilk.	First Washings.	Second Washings.
Mineral matter,	.77	1.14	.15	.68
Curd,*	3.00	3.25	.50	.25
Sugar, by difference,	4.07	5.23	.61	.25
Fat,	16.28	.16	.08	.04
Water,	75.88	90.22	98.66	98.78
	100.00	100.00	100.00	100.00

* Throughout this paper "curd" denotes all the nitrogenous matter of the milk products, and its per cent. is the product of the per cent. of nitrogen multiplied by 6.25.

† The mixture of 730½ pounds of cream and 8½ pounds of water.

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There went into the churn, in pounds :—

			Fat.	Curd.	Sugar.	Mineral Matter.	Water.
Cream	$738\frac{1}{16}$	pounds, containing	120.16	22.14	30.04	5 68	560.04
Water, for rinsing, washing and floating the butter	$756\frac{3}{16}$	" "	----	----	----	----	756.18
There was added during the working, salt	$8\frac{3}{16}$	" "	----	----	----	8.56	----
Total	$1502\frac{13}{16}$		120.16	22.14	30.04	14.24	1316.22

There was taken out of the churn, in pounds :—

Buttermilk	$534\frac{6}{16}$	pounds, containing	.85	17.37	27.95	6.09	482.11
First Washings	$534\frac{15}{16}$	" "	.43	2.67	3.26	.80	527.77
Second Washings and draining from butter	$239\frac{3}{16}$	" "	.09	.60	.60	1.63	236.20
Butter, worked only once (by difference)	$196\frac{3}{16}$	" "	118.79	1.50	----	5.72	70.14
Total	$1504\frac{19}{16}$‡		120.16	22.14	31 81‡	14.24	1316.22

‡ Excess due to errors of sampling and analysis.

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In this case 1.37 pounds or 1.14 per cent. of the total butter-fat was lost in the buttermilk and washings; otherwise expressed, for every 100 pounds of finished butter made, one pound and two and one-quarter ounces of butter were lost in the buttermilk and washings.* This is a very much larger percentage of loss than was found in any of our subsequent experiments. There is little doubt that it is due to the fact that a portion of the cream had been frozen. From such cream good churning results are not to be expected. The results are introduced here, because they are instructive in showing what heavy losses may arise from this cause. At this point the Station representative was obliged to leave the work on account of serious illness.

On the 2d of May the observations were taken up again. The plan followed was the same as before except that the cream was weighed but once and at the time when it was received from the cream gatherer. Samples of the cream, butter, and other products were sent to the Station, preserved when necessary by corrosive sublimate or potassium bichromate, and were analyzed in duplicate by gravimetric methods.

Cooley Cream.

There was received at the Creamery at 9.10 A. M., 411½ pounds of Cooley cream, having a temperature of 48 degrees. At 11 A. M. the temperature was raised to 70°. From time to time the degree of acidity of the cream was determined and is expressed in the following table in per cent. of lactic acid:

Time.	Temperature of Milk.	Per cent. of Lactic Acid.
May 2d, 9.10 A. M.	48° F.	.25
" 11.00 "	"	--
" 12.00 "	72° F.	--
" 2.00 P. M.	70½° F.	.31
" 3.00 "	70° F.	.35
" 4.00 "	69° F.	.37
" 5.00 "	"	.38
May 3d, 5.30 A. M.	64° F.	.71

The cream was cooled to 62° F., and churned in the Davis Swing Churn May 3d, at 9.50 A. M. The time occupied in churning was 55 minutes. The details of the test are here presented in tabular form.

* Reckoning that the finished butter contains 82 per cent. of butter fat.

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ANALYSES OF THE COOLEY CREAM, BUTTER AND BY-PRODUCTS.

	Cooley Cream.	Butter-milk.	First Washings.	Second Washings.	Butter.
Mineral matter	.57	.60	.14	.17	3.07
Curd	2.78	2.69	.66	.16	1.03
Sugar, by difference	3.98	3.79	1.02	.27	....
Fat	16.08	.08	.02	.00	82.80
Water	76.59	92.84	98.16	99.40	13.10
	100.00	100.00	100.00	100.00	100.00

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There went into the churn, in pounds :—

			Fat.	Curd.	Sugar.	Mineral matter.	Water.
Cream	411 8/16	containing	66.17	11.44	16.38	2.35	315.16
Water for rinsing, washing and floating the butter	612	"	....	....	....	....	612.00
There was added during the working, salt	4 1/16	"	....	....	....	4.06	....
Total	1027 9/16	"	66.17	11.44	16.38	6.41	927.16

There was taken out of the churn, in pounds:—

Buttermilk	317 14/16	containing	.25	8.55	12.05	1.91	295.12
First washings	372 10/16	"	.08	2.46	3.80	.52	365.76
Second washings and draining from the butter	239 4/16	"	....	.38	.65	.41	237.81
Butter, worked twice and ready to print	79 13/16	"	66.03	.82	....	2.45	10.45
Total	1009 8/16	"	66.36	12.21	16.50	5.29	909.14

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It appears from this balance sheet that in the 26 weighings involved in the experiment there is an apparent error of 18.06 pounds, or 1.7 per cent. of the whole weight.

There is an apparent loss of water and salt amounting to 19.14 pounds which is due to unavoidable mechanical loss in handling these large quantities of water and washings, and to losses on the butter worker which on account of its construction, it was impossible to avoid. The quantity of sugar in the products from the churning is practically the same as the quantity found in the cream. There appears a small excess of both butter-fat and of curd in the products of the churning, amounting in the former to about three ounces and in the latter to 12 ounces. This discrepancy is chiefly due to imperfect sampling of the butter. It is extremely difficult to draw a sample of butter which shall accurately represent the lot from which it is drawn. The water in the butter is not evenly diffused through it but is in drops which yield to the slightest pressure and run off so that one is likely to get in the sample a less proportion than the whole mass contains. These discrepancies, however, do not affect the value of the observations for the present purpose. It appears that of the 66.17 pounds of butter-fat which went into the churn, .33 pounds or 5.3 ounces were lost in buttermilk and washings. This amounts to .5 per cent. of the total fat. Otherwise expressed, for every 100 pounds of butter made, 6.4 ounces of butter-fat or 8 ounces of butter were lost in the buttermilk and washings.*

Separator Cream.

A batch of cream separated by the DeLaval machine, representing the milk from three patrons, was also received at the creamery on May 2d. Its weight was 284.4 pounds and its temperature when received was 56°, or 8° warmer than the Cooley cream. It was also apparent that it had not been properly cared for by the producers, because it was quite sour when received as the following table shows. It was weighed and brought into the ripening vat at 11.30 A. M. The temperature and course of ripening is shown in the table:

* Whenever in this paper it has been desirable to calculate the butter represented by small quantities of butter-fat, it has been done by multiplying the weight of butter-fat by 1.22, thus assuming that average butter contains 82 per cent. of fat.

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Time.		Temperature.	Per cent. of Lactic Acid.
May 2d,	9.30 A. M.	56° F.	.56
"	11.30 "	58°	.56
"	12.10 P. M.	58°	.56
"	2.00 "	62°	.56
"	3.00 "	62°	.57
"	4.00 "	63°	.58
"	5.00 "	63°	.61
May 3d,	5.30 A. M.	61°	.70

The acidity of the cream when churned was precisely the same as that of the Cooley cream already spoken of. The cream after adding water to thin it, was churned at a temperature of 60°. The churning required 30 minutes. The further conduct of the experiment may be learned from the following table:

ANALYSES OF THE SEPARATOR CREAM, BUTTER AND BY-PRODUCTS.

	Cream.	Buttermilk.	First Washings.	Second Washings.	Butter.
Mineral matter	.76	.50	.11	.32	4.35
Curd	2.38	2.31	.50	.22	.82
Sugar	3.79	3.72	.69	.16	....
Fat	26.08	.21	.01	..	82.56
Water	66.99	93.26	98.69	99.30	12.27
	100.00	100.00	100.00	100.00	100.00

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There went into the churn, in pounds:—

			Fat.	Curd.	Sugar.	Mineral Matter.	Water.
Cream	$284\frac{6}{16}$	pounds, containing	74.17	6.77	10.78	2.16	190.52
Water for rinsing, washing and floating the butter	$575\frac{1}{16}$	" "	....	....	....	....	575.07
There was added during the working, salt	$5\frac{15}{16}$	" "	....	....	....	5.94	....
Total	$865\frac{6}{16}$		74.17	6.77	10.78	8.10	765.59

There was taken out of the churn, in pounds:—

Buttermilk	$227\frac{14}{16}$	pounds, containing	.48	5.26	8.48	1.14	212.52
First Washings	$352\frac{13}{16}$	" "	.04	1.76	2.43	.39	348.13
Second Washings and draining from the butter	$191\frac{6}{16}$	" "	....	.42	.31	.61	190.04
Butter, worked twice and ready to print	$88\frac{9}{16}$	" "	72.76	.72	....	3.83	10.82
Total	$860\frac{9}{16}$		73.28	8.16	11.22	5.97	761.51

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There is here an apparent loss of about 6 pounds of water and salt, to be explained as in the former case. The sugar in the churn products tallies very nearly with that of the cream which was put in. There is an apparent gain of 1.4 pounds of curd, due to imperfect sampling of the butter, and a loss of .9 pounds of fat. The actual loss of fat in the buttermilk and washings amounts to .52 pounds; that is, of the 74.17 pounds of butter-fat which went into the churn, .52 pound or 8.3 ounces were lost in buttermilk and washings. This amounts to .7 per cent. of the total butter-fat. Or expressed otherwise, for every 100 pounds of butter made, 11½ ounces of butter are lost in buttermilk and washings.

Mixed Cooley and Separator Cream.

On May 3d there was weighed into the ripening vat as it was received from the cream gatherer, 129.5 pounds of Separator cream, and 225.9 pounds of Cooley cream; total 355.4 pounds. This was received at noon and warmed at once to 70° F. The following observations were made on the temperature and acidity.

Time.	Temperature.	Per cent. of Lactic Acid.
May 3d, 12.00 M.	70° F.	--
" 2.00 P. M.	70°	.35
" 3.00 "	70°	.40
" 4.00 "	70°	.46
May 4th, 5.30 A. M.	63°	.65

At 7.00 A. M., May 4th, this mixed cream was churned at a temperature of 61°. The churning required one hour and 15 minutes. The further details of the experiment will appear in the following statement:

Analyses of the Mixed Cream, Butter and By-Products.

	Mixed Cream.	Buttermilk.	First Washings.	Second Washings.	Butter.
Mineral Matter	.59	.54	.11	.16	4.78
Curd	2.78	2.28	.66	.09	1.07
Sugar	4.17	3.66	.86	.45	....
Fat	18.95	.11	.02	.00	83.53
Water	73.51	93.41	98.35	99.30	10.62
	100.00	100.00	100.00	100.00	100.00

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There went into the churn :—

			Fat.	Curd.	Sugar.	Mineral Matter.	Water.
Cream	$355\frac{6}{16}$ pounds, containing		67.35	9.88	14.82	2.10	261.22
Water for rinsing, washing and floating the butter	$608\frac{10}{16}$	" "	....	....	....	....	608.63
There was added during the working, salt	$5\frac{15}{16}$	" "	....	....	....	5 94	....
Total	$969\frac{15}{16}$		67.35	9.88	14.82	8.04	869.85

There was taken out of the churn :—

Buttermilk	$318\frac{8}{16}$ pounds, containing		.35	7.26	11.66	1.72	297.51
First Washings	$359\frac{8}{16}$	" "	.07	2.37	3.09	.40	353.57
Second Washings and draining from the butter	189	" "	....	.17	.85	.30	187.68
Butter worked twice and ready to print	$78\frac{12}{16}$	" "	65.78	.84	....	3 77	8.36
Total	$945\frac{12}{16}$		66.20	10.64	15.60	6.19	847.12

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The larger deficit of water in this observation was due to the accidental loss of a part of the second washings, which, however, involved no loss of fat. An apparent gain of curd and loss of mineral matter (salt), due to errors and losses of experiment, is noted here as in the previous cases. There is also a deficiency of 1.15 pounds of butter-fat due to errors in sampling the butter. The analyses of the buttermilk and washings show that they contained .42 pounds of butter-fat, which of course was lost to the creamery. This is .62 per cent. of the total butter-fat. Otherwise expressed, in making 100 pounds of butter, there has been lost 10⅘ ounces of butter.

Omitting the first test which was made with damaged cream and was not carried to its full conclusion, the results of the three tests may be summarized as follows:

Losses in Buttermilk from Churning Mixed Cream of Creamery Patrons.

For every 100 pounds of butter made, there is lost in the buttermilk and washings:

	Ounces of butter.	Money equivalent.*
Cream raised by the Cooley system.....	8	16 cents.
Cream raised by the Separator system.....	11 1-2	23 "
Mixture of cream raised by the two systems	10 2-5	21 "

The foregoing tests were made with large quantities of cream ripened and churned in precisely the same way as all the rest of the cream which is taken to the creamery and show the losses of butter in the buttermilk and washings which occurred in every day practice at this creamery with Cooley cream, Separator cream and mixtures of the two, at the time these experiments were undertaken. They show that there was a money loss in the buttermilk and washings from Separator cream greater by seven cents per 100 pounds of butter made, than in the buttermilk and washings from the Cooley cream. The losses in buttermilk and washings from a mixture of Separator and Cooley cream were a little less than in those from Separator cream alone. It should be remarked that the Separator cream whenever it came under observation of the Station chemist, was already quite sour when it reached the creamery, being considerably warmer than the Cooley cream. This ought not to be and it is a fault not of the

* Butter at 32 cents per pound.

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system but of the patron, due to carelessness. There is no necessity for sour cream in May. Separator cream should be cooled below 50° as soon as separated and kept in a cold, clean place till taken by the cream gatherer. The place to ripen cream is the creamery, not the pantry or milk room of the patron, and to insure the best quality of butter, the *whole* of the cream must come sweet to the creamery. It has been fully demonstrated that the best butter cannot be made from a mixture of portions of cream of different degrees of ripeness, and in this comparison the Separator cream suffers because of this souring previous to its coming to the creamery.

The above tests are made with cream from different herds. The Cooley cream came from a considerable number of herds and was mixed by the cream gatherer. The Separator cream came from three or four *other* herds. It is quite possible that the one lot of cream, represented on the whole, cows better kept and better fed, and cream better protected from contamination before being turned into the creamery, than the other. It may also be claimed that neither the Separator nor the Cooley system was in in all cases properly used by the patrons; so that the results do not show what the two systems can do *at their best.*

These considerations made it desirable to carry out still another trial which we were able to do by the courtesy of Mr. Gardiner Sumner, of Woodstock, who placed the milk of his herd at our disposal for the week beginning November 6th.

This herd consists of five grade Guernseys, three thoroughbred and five grade Jerseys, and one grade Short-horn.

Their feed was two quarts of bran, one of corn-meal and one of gluten feed per day and head, with hay in the morning and a feed of pumpkins at night. The herd was turned to pasture during the day.

The milking was begun punctually at six o'clock morning and evening. The milk was always brought to the milk-room as soon as two pails were filled, was strained at once into Cooley cans which were then promptly submerged in water of from 40° to 44° F., containing ice to keep the temperature down.

The milk stood ten hours during the day and eleven hours during the night, before skimming.

The DeLaval Separator was furnished for these tests by the DeLaval Separator Co., of New York, and it was operated by their agent, Mr. F. J. Parker.

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The cream was weighed always by the Station representative on scales sensitive to one-quarter of an ounce, and when poured from one vessel to another the emptied vessel was carefully rinsed with a very little water which was added to the cream.

The general plan followed was to set by the Cooley system, the milk of one night and of the following morning. The night's milk was skimmed at 5 A. M., the morning's milk at 4.00 to 4.30 P. M.

The cream from these two settings was immediately mixed and taken to the creamery.

From the milk of the following night and morning the cream was taken by the DeLaval Separator, mixed and immediately carried to the creamery.

Each lot of cream, as soon as it was received there, was put into deep cans, standing in a tank of water, and kept as nearly as possible at 70° F. till it was ripe and ready for churning.

The churning was done by hand in a barrel churn of the so-called "Surprise" pattern.

All weights were made by the Station representative. The care of the cream and the churning, however, was entirely under the management of the butter maker, Mr. Hopkins. The buttermilk was carefully weighed and analyzed to ascertain directly the loss of fat in it.

The weather during the whole experiment was quite alike from day to day, being uniformly fair with sharp frost at night. The details of the experiment follow. The general result is given on pages 162 and 163.

Cooley Cream.

The Cooley cream from night's milk of November 8th, and morning's milk of November 9th weighed 58.75 pounds, and its temperature was 53° F. when taken to the creamery. It contained 10.08 pounds of butter-fat. It was brought to 70° immediately and kept there till into the evening. During the night it cooled to 64° but at 6 A. M. on the 10th it was brought to 70° and kept there through the day, with occasional stirring. At night it fell again to 60° and was again brought on the morning of the 11th to 70° and held there till 4.30 P. M., when it was ripe enough to churn.

It required nearly forty-six hours to ripen this lot.

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It was cooled to 56° and churned at that temperature. The churning took 27 minutes and the butter came in fine-granular condition.

The buttermilk weighed 61.37 pounds and contained .035 per cent. or $\frac{84}{100}$ ounces of butter-fat.

From the churning there was made 12 pounds of butter. Hence for every 100 pounds of butter made there was lost in the buttermilk 3.5 ounces, the equivalent of 7.0 cents.

Separator Cream.

The Separator cream from the night's milk of November 9th and morning's milk of November 10th weighed 34.23 pounds, contained 10.23 pounds of butter-fat and had a temperature of 63° when received at the creamery. It was kept at 70° from 9.30 A. M. of the 10th till 2.30 of the 11th, 29 hours in all, except that during the night the temperature sank to 60°. It was churned at a temperature of 50° F. in the barrel churn. Twenty-two minutes were required for the churning and the butter came in excellent condition, fine-granular and firm.

The buttermilk weighed 37 pounds and contained .085 per cent. or $\frac{59}{100}$ ounce of butter-fat.

From the churning was made 12.56 pounds of butter.

Hence for every 100 pounds of butter made there was lost in the buttermilk 4.9 ounces of butter; the equivalent of 9.8 cents.

Mixed Cooley and Separator Cream.

The Cooley cream from the night's milk of November 10th and the morning of November 11th was mixed with the Separator cream from the night's milk of November 11th and the morning's milk of November 12th and the mixture was brought to the creamery.

The total weight of cream was 101.65 pounds and contained 21.02 pounds of butter-fat.

It was received at the creamery at 10 A. M. of the 12th and was brought at once to 70° and held at that temperature, except as it fell during the night time, till 7.30 A. M. on the 14th when the cream was ripe for churning. Time of ripening, 45½ hours. The cream was cooled to 53°–54° F. and churned in the barrel churn. The quantity of cream, double that used in the other two

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tests, was a little more than could be conveniently handled in this churn. It would have been better to make two churnings of it. The butter came in 16½ minutes, but did not seem as fine as the previous lots nor was it as distinctly granular.

The buttermilk weighed 87.19 pounds and contained .095 per cent. or $1\frac{82}{100}$ ounces of butter-fat.

From the churning were made 25¼ pounds of butter.

Hence for every 100 pounds of butter made there was lost in the buttermilk 6.3 ounces of butter, the equivalent of 12.6 cents.

The two sets of observations may now be summarized. The first set shows what losses of butter-fat in the buttermilk and washings are to be expected in general creamery practice when Cooley cream and Separator cream are ripened and churned, each by itself, and when the two kinds of cream are mixed before ripening and are churned together. The Separator cream in these experiments was quite sour when it reached the creamery, showing that it had not been properly cared for by the patrons.

The second set of observations shows the losses of butter-fat in buttermilk and washings when cream properly raised and handled from one and the same herd, is used for the comparison of the Cooley and Separator systems and for the churning of a mixture of the two.

Losses of Fat in Buttermilk.

For every 100 pounds of butter made there is lost in the buttermilk and washings:

	Ounces of butter.	Money equivalent.
Cooley system, mixed cream of different herds	8	16 cents.
Cooley system, cream of single herd properly handled	3 1-2	7.0 "
Separator system, mixed cream of different herds	11 1-2	23 "
Separator system, cream of single herd properly handled	4 9-10	9.8 "
Mixed Cooley and Separator system, cream of different herds	10.4	21 "
Mixed Cooley and Separator system, cream of one herd	6 3-10	12.6 "

The general results are as follows:

First: There was in every case, a larger loss of butter in the buttermilk from Separator cream than from Cooley cream.

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Second: In one case this increased loss by the Separator system amounted to 7 cents for every 100 pounds of butter made; in the other case to 3 cents, less than half as much.

Third: It is fair to suppose that the losses in buttermilk could be reduced one-half, at least, if the milk and cream were properly handled by the patrons.

Fourth: The loss of butter in the buttermilk, from a churning of mixed Cooley and Separator cream, is not very different from the loss in a churning of Separator cream by itself.

The quality of the butter made by the two systems will be spoken of further on.

The losses of fat in the buttermilk are not by any means the only ones in the creamery, nor are they always the largest losses. Experiment has shown that there is often a considerable mechanical loss due partly to carelessness in draining the cream-carriers as well as to the sticking of cream and butter to the utensils during ripening, churning and butter-working.

To reduce the mechanical loss of cream as much as possible, the Separator should be set to deliver the cream as thin as the cream from deep-setting systems.

2. COMPARISON OF THE RELATIVE EFFICIENCY OF THE DELAVAL SEPARATOR AND THE COOLEY SYSTEM FOR SEPARATING CREAM.

In connection with the work above described, the opportunity was taken to test the efficiency of these two systems side by side on milk of the same herd and of nearly the same composition.

The details of the tests will be given first for the benefit of any who wish to make a critical examination of them and the final results will be concisely stated in conclusion for the general reader.

The first tests were made during the week beginning Monday, May 22, on the farm of Mr. Sumner, already referred to. Fourteen of the cows were the same described on page 159. They were all old in milk, most of them having calved in September and October, 1892. Eighteen cows were being milked. They were at pasture but were fed corn meal and shorts. The cows are kept with very exceptional neatness. The stables are very clean and the cows, bags and teats are washed off every morning

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before milking. The same neatness and care characterize the handling of the milk and cream. The milk in all the following experiments and in accordance with Mr. Sumner's usual practice is brought as soon as two pails are ready from the stable to the milk room which is near by, strained into Cooley cans which are immediately submerged in the tank, in water having a temperature of from 40° to 44°. The times of milking and of skimming given in the last experiments were here observed, and the cream was cared for in the same way.

Experiments of May 22d to May 26th.

May 22d, evening. Cooley system. Temperature of water in which the milk was submerged, 42°; temperature at skimming time, 48°.

May 23d, morning. Cooley system. Temperature of water, 45°. Ice was immediately added to reduce temperature to 42°. Temperature at skimming time, 47°.

May 23d, evening. DeLaval separator (Baby, No. 2), operated by Mr. Lindermann. It was run with about 48 revolutions of the crank per minute. After the milk was run through, a quart or two of skim milk was used to free the bowl of the Separator from cream.

May 24th, morning. DeLaval separator.

May 24th, evening. Cooley system. Temperature of water, 43°. Temperature at skimming time, 45°.

May 25th, morning. Cooley system. Temperature of water, 45°.

May 25th, evening, and May 26th, morning. DeLaval separator.

The weighings and analytical results for economy of space are all given together in the following table:

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COMPARISON OF EFFICIENCY OF SKIMMING BY COOLEY SYSTEM AND DELAVAL SEPARATOR.

Observations of May 22d to May 26th, 1893.

	MILK.			CREAM.				SKIM-MILK.			
	Weight. Pounds.	Per cent. of Fat.	Weight of Butter-Fat. Pounds.	Spaces.	Weight. Pounds.	Per cent. of Fat.	Weight of Butter-Fat. Pounds.	Weight. Pounds.	Per cent. of Fat.	Weight of Butter-Fat. Pounds.	In 1000 lbs. of milk having 4.3 per cent. of fat there is lost of Butter-Fat. Pounds.
Cooley System, Monday P. M.	168.75	4.71	7.948	57	43.25	17.68	7.647	125.500	.242	.304	
" " Tuesday A. M.	123.50	5.24	6.471	49	35.875	17.37	6.231	88.125	.275	.242	
Total	292.25		14.419	106	79.125		13.878	213.625		.546	1.85
Cooley System, Wednesday P. M.	145.875	4 53	6.608	48	36.875	17.26	6.365	109.000	.23	.251	
" " Thursday A. M.	131.375	5.29	6 949	51	38.750	17.34	6.719	92.625	.26	.241	
Total	277.250		13.557	99	75.625		13.084	201.625		.492	1.77
DeLaval Separator, Tuesday P. M.	140.875	4.48	6.311	--	19.875	30.60	6.082	121.000	.195	.236	
" " Wednesday A. M	124.500	5.36	6.673	--	20.375	31.78	6.475	104.125	.195	.203	
Total	265.375		12.984	--	40.250		12.557	225.125		.439	1.65
DeLaval Separator, Thursday P. M.	149.375	4.56	6.811	--	27.375	24.07	6.589	122.000	.18	.220	
" " Friday A. M.	117.000	5.09	5.955	--	21.875	26.72	5.845	95.125	.105	.100	
Total	266.375		12.766	--	49.250		12.434	217.125		.320	1.23

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The table shows that something over 500 pounds of milk was creamed in four different lots, by each method.

The milk was from the same herd and contained, practically, the same per cent. of fat; the milk creamed by the Cooley system containing 4.94 per cent. of fat, that by the DeLaval, 4.87.

The average per cent. of fat in the Cooley skim milk was .25; in Separator skim milk, .17 per cent.

In 1000 pounds of milk creamed .37 of a pound of butter-fat was lost in the Cooley skim milk, which was saved by the DeLaval separator.

The losses of butter-fat in handling and churning the Separator cream, were, however, larger than in handling Cooley cream, so that in this test notwithstanding the somewhat closer skimming by the Separator system, it required to make one pound of butter, 16.4 pounds of milk creamed by the Separator and 15.9 pounds of milk creamed by the Cooley system.

Sample prints of the butter from Cooley cream, marked B, and of the butter from Separator cream marked A were immediately submitted to Mr. O. Douglass, of Boston, to be scored, no information being given him regarding the origin of the samples. Following is his report:

	Perfect.	Sample A, Separator Butter.	Sample B, Cooley Butter.
Flavor	50	50	50
Texture and grain	30	28	30
Color	10	10	10
Salt	10	10	10
	100	98	100

The quantity of fat left in the skim milk by the Separator was so much more than has been found in other observations as to create the suspicion that either the Separator itself was not in order or that it was not run at the proper speed.

It was accordingly thought best to make still another comparison, which was done early in November.

Experiments of November 6th to November 12th.

The weather during this test was fair, no rain or snow falling for the week. The days were warm, "Indian Summer," the nights frosty, making a thin sheet of ice on shallow pools.

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The cows were fed a mixture of two quarts of bran, one quart corn meal and one quart gluten feed per day and head with a ration of hay in the morning and pumpkins at night. They pastured during the day. The milk and cream were handled as in the experiments on Mr. Sumner's farm, already described. The DeLaval Separator was furnished by the DeLaval Separator Co., and was operated by their agent, Mr. F. J. Parker. After the whole of the milking was run through the Separator a weighed quantity of warm water was run through the machine to clear out all cream from the bowl. This water went into the skim milk.

November 6th, evening. Cooley system. Temperature of water, 43°.

November 7th, morning. Cooley system. Temperature of water, 40°.

November 7th, evening and November 8th, morning. DeLaval Separator.

November 8th, evening. Cooley system. Temperature of water, 43°.

November 9th, morning. Cooley system. Temperature of water, 44°.

November 9th, evening and November 10th, morning. DeLaval Separator.

November 10th, evening. Cooley system. Temperature of water, 42°.

November 11th, morning. Cooley system. Temperature of water not recorded.

November 11th, evening and November 12th, morning. DeLaval Separator.

It appears that in this test, for every 1000 pounds of milk creamed, 2.06 pounds of butter-fat were lost by the Cooley system which were saved by the Separator.

The results of churning tests show that to make one pound of butter there were required on the average, 17 pounds of milk creamed by the Separator system and 17.9 pounds of the same milk creamed by the Cooley system.

From the butter made from the Cooley cream of November 6th, evening, and November 7th, morning, a sample pound package was made, marked G.

A sample from the butter made from Separator cream of November 7th, evening, and November 8th, morning, was marked B.

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COMPARISON OF EFFICIENCY OF SKIMMING BY COOLEY SYSTEM AND DELAVAL SEPARATOR.

Observations of November 6th to November 12th, 1893.

	MILK.			CREAM.				SKIM-MILK.			
	Weight. Pounds.	Per cent. of Fat.	Weight of Butter-Fat. Pounds.	Spaces.	Weight. Pounds.	Per cent. of Fat.	Weight of Butter-Fat. Pounds.	Weight. Pounds.	Per cent. of Fat.	Weight of Butter-Fat. Pounds.	In 1000 lbs. of milk having 4.9 per cent. of fat, is lost of Butter-Fat. Pounds.
Cooley System, Nov. 6, P. M.	119.130	4.24	5.051	41	31.44	15.56	4.892	87.69	.19	.167	
" " " 7, A. M.	102.375	4.95	5.068	35	27.13	17.44	4.732	75.245	.45	.339	
Total	221.505		10.119	76	58.57		9.624	162.935		.506	2.45
Cooley System, Nov. 8, P. M.	108.750	4.70	5.111	38½	30.03	16.43	4.934	78.72	.23	.181	
" " " 9, A. M.	114.685	5.19	5.952	40	30.825	17.85	5.502	83.86	.53	.444	
Total	223.435		11.063	78½	60.855		10.436	162.58		.625	2.77
Cooley System, Nov. 10, P.M.	128.855	4.52	5.824	45	34.28	16.17	5.543	94.575	.29	.274	
" " " 11, A. M.	118.090	5.12	6.046	40	31.59	17.46	5.516	86.50	.62	.536	
Total	246.945		11.870	85	65.87		11.059	181.075		.810	3.35
Separator System, Nov. 7, P. M.	110.560	4.67	5.163	--	14.20	35.83	5.088	101.81	.08	.081	
" " " 8, A. M.	93.990	5.32	5.000	--	14.47	34.12	4.937	86.50	.07	.061	
Total	204.550		10.163	--	28.67		10.025	188.31*		.142	.68
Separator System, Nov. 9, P. M.	119.370	4.66	5.563	--	18.31	29.99	5.491	104.53	.07	.073	
" " " 10, A. M.	102.740	5.12	5.260	--	17.44	29.78	5.194	90.28	.08	.072	
Total	222.110		10.823	--	35.75		10.685	194.81†		.145	.65
Separator System, Nov. 11, P. M.	119.385	3.83	4.572	--	16.265	27.24	4.431	103.12	.14	.144	
" " " 12, A. M.	138 860	4.39	6.096	--	22.060	27.22	6.005	118.25	.07	.083	
Total	258.245		10.668	--	38.325		10.436	221.37‡		.227	1.03

* Including 12.43 pounds of water to clear the bowl of cream. † Including 8.45 pounds of water to clear the bowl of cream.

‡ Including 1.45 pounds of water to clear the bowl of cream.

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The sample from Cooley cream of November 8th, evening, and November 9th, morning, was marked A.

The sample from Separator cream of November 9th, evening, and November 10th, morning, was marked H.

The Cooley cream of November 10th, evening, and November 11th, morning, was mixed with Separator cream of November 11th, evening, and November 12th, morning, and the two lots were ripened and churned together.

This lot was too large to be conveniently churned in the barrel churn at one time and should have been churned in two lots. The sample package was marked F.

These five samples were immediately taken to Mr. Fales, of the firm of Fales & Lehy, dealers in butter, cheese and eggs, 30 and 32 Commercial street, Boston, Mass. Mr. Fales has acted as judge of butter at the State Dairymen's Association in this State and is considered as competent a judge of butter as can be found. After examination, in which he pronounced A the best as regards flavor, and F the poorest in texture, it was decided to leave the samples in his care in cold storage for a few days as the butter was then too fresh to judge closely of its texture and grain. No information regarding the origin of the samples was given to Mr. Fales and no one excepting the representative of the Station knew the significance of the letters by which the samples were marked. The judgment of Mr. Fales is as follows:

	Flavor.	Texture and grain.	Color.	Salt.	Total.
Perfect quality requires	50.0	30	10	10	100
Sample A, Cooley	48.0	30	10	10	98
" G, Cooley	42.0	30	10	10	92
" B, Separator	47.0	30	10	8	95
" H, Separator	46.0	30	10	10	96
" F, mixed Cooley and Separator	47.0	27	10	10	94

Mr. Fales also wrote, "Sample F would have been a fine piece of butter if there had been any body to it. It was either worked too much or there was some trouble with the cream."

The batch of cream from which this lot of butter was made was twice as large as any of the others, and should have been divided and churned in two portions. It is believed that its texture suffered because this was not done. If so, its low score should be charged to errors of manipulation rather than to the character of the cream.

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One ounce of salt was added to each pound of butter at the first working. All of the samples are graded perfect in salt except B, Separator, which is scored off two points but whether because of deficiency or excess of salt is not known.

Conclusions.

The relative merits of the two systems of creaming are not to be established by any single experiment or series of experiments. The object of these tests was in part to meet certain extravagant claims and charges made by interested persons regarding the two methods.

The observations show that in these tests which were made with all possible care:

1. There was no significant difference in the quality of the butter made from cream raised by the Cooley system and by the Separator system.

2. In each trial the Separator got more butter-fat from 1000 pounds of milk than the Cooley system of creaming.

The Cooley system left from 1.77 to 3.35 pounds of butter-fat in skim milk from 1000 pounds of whole milk while the Separator in milk of the same composition left from .65 to 1.65 pounds.

3. The losses of fat in the buttermilk and butter washings were in both tests larger when Separator cream was churned than when Cooley cream was churned.

The loss in Separator cream over and above that in Cooley cream was equal to from 1 1-2 to 3 1-2 ounces of butter in every 100 pounds of butter made.

4. When Cooley cream and Separator cream were ripened and churned together the loss of fat in the butter milk and washings was about the same as when Separator cream was ripened and churned by itself.

5. In one test it required 15.9 pounds of milk creamed by the Cooley system to make a pound of butter and 16.4 pounds of same milk creamed by the Separator to make a pound of butter.

In the second test it required 17 pounds of milk creamed by the Separator to make a pound of butter and 17.9 pounds of the same milk, creamed by the Cooley system.

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ON THE GUNNING-KJELDAHL METHOD AND A MODIFICATION APPLICABLE IN THE PRESENCE OF NITRATES.*

By A. L. Winton.

The Gunning-Kjeldahl Method (in absence of nitrates.)

The modification of the Kjeldahl method, proposed by Gunning in 1889, has since been indorsed by a number of well-known chemists.

The Gunning method is very simple, the only reagents used previous to the distillation with caustic soda being sulphuric acid and potassium sulphate, the latter taking the place of the three reagents—mercury (oxide or metallic), potassium permanganate and potassium sulphide—ordinarily used.

The mixture of sulphuric acid and potassium sulphate boils at a high temperature, and, as a rule, oxidizes the organic substance more rapidly than the ordinary mixture of sulphuric acid and oxide of mercury.

The results obtained by Gunning,† Atterberg,‡ Van Slyke§ and others, including the writer, on fodders, dairy products, fertilizers free from nitrates, and various organic substances, show that this method is fully as accurate as the ordinary Kjeldahl method, and, in some cases, gives better results. It is a well known fact that the nitrogen of many alkaloids, azo-compounds and various bodies of the aromatic series cannot be determined by the usual Kjeldahl method, but Gunning and Atterberg have obtained good results on morphine, quinine, indigo and aniline oxalate by the Gunning modification.

The chief disadvantage of the method is the frothing which occurs during the first part of the heating. This frothing, however, causes but little trouble if a flask of at least 500 c.c. capacity (which can afterwards be used for the distillation), is employed and care be taken in adjusting the heat.

* Published as Bulletin No. 112, in June 1892, but by an oversight not included in the Annual Report for that year. It is here reprinted without essential change except that 12 additional test-analyses are appended to the 25 originally given at the conclusion, p. 148.

† Fres. Zeit., **28**, 188.

‡ Chem. Zeitung, **14**, 509.

§ U. S. Dept. Agr. Div. Chem. Bull., **31**, 142.

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The Gunning mixture is, at ordinary temperatures, half-solid, and must be heated before it can be measured for use. It is therefore best to add 18 grams of potassium sulphate and 20 c.c. of sulphuric acid, separately and in the order named, to the flask containing the substance, shaking a few times before heating. The coarsely powdered sulphate may be conveniently measured out in a cartridge-shell adjusted to hold 18 grams and provided with a wire handle. The acid may be added from a graduated cylinder or a burette of wide calibre connected by a siphon with the acid reservoir.*

After the digestion is completed water should be added before the mixture becomes too cold, otherwise it is difficult to obtain a solution of the solid mass.

The writer has found that the fertilizer-chemical known in the trade as "High Grade Sulphate of Potash," and costing but a few cents a pound, answers every purpose, and is, in fact, better than the white sulphate of the apothecary, being usually free from moisture and chlorides, the presence of which tends to increase the frothing.

Following is a comparison of results, obtained by the methods named, on those forms of organic nitrogenous matter which are most commonly used in mixed fertilizers, and on four commercial fertilizers free from nitrates.

	Kjeldahl Method.	Gunning-Kjeldahl Method.
Cotton Seed Meal	7.06	7.11
" " "	7.10	7.13
" " "	7.10	7.15
" " "	6.95	6.97
Castor Pomace	5.56	5.59
Tankage	5.03	5.07
"	5.72	5.82
Bone	4.03	4.02
"	3.92	3.90
Dry Ground Fish	8.69	8.77
" "	8.14	8.06
Peruvian Guano	2.88	2.95
Mixed Fertilizer †	3.45	3.45
" " ‡	3.00	3.00
" " §	3.80	3.76
" "	1.82	1.81

* Report Conn. Agr. Expt. Station, 1889, 192.

† Contains 1.89 per cent. Nitrogen in Ammonia salts.

‡ " 1.76 " " " "

§ " 1.77 " " " "

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The Modified Method applicable in the presence of Nitrates.*

In laboratories where fertilizer analyses are being made, the adoption of the Gunning method would tend to complicate rather than to simplify matters so long as in the presence of nitrates nitrogen is determined by another method.

It is impracticable to add salicylic acid to Gunning's reagent as such a mixture could only be used while hot and it is important that the temperature be kept as low as possible during the early stages of the digestion. It occurred to the writer, however, that Scovell's mixture of sulphuric and salicylic acids might be used in the ordinary way, potassium sulphate being added later in the process in place of mercury. After a number of unsuccessful trials—unsuccessful because too much potassium sulphate was used and the boiling point of the liquid became so high that oxides of nitrogen were driven off—the following plan was settled upon.

The material, .5 to 1.0 gram, is digested with 30 c. c. of Scovell's salicylic acid mixture (30 c. c. of sulphuric acid and 2 gms. salicylic acid) in a flask of 600 c. c. capacity, for two hours with frequent shaking. Two grams of zinc dust are then slowly added, with continual shaking, and the flask heated, at first gently, until after a few minutes boiling, dense fumes are no longer given off. Thus far the process is the same as in the Scovell-Kjeldahl method (the official method of the Association of Official Agricultural Chemists) except, that the digestion is continued for two hours, which, in some cases, the writer has found absolutely necessary in order to secure complete solution of the nitrate. Ten to twelve grams of potassium sulphate are next added and the boiling continued for a little time after the solution is colorless or, if iron is present, has a light straw color which remains unchanged. On cooling, as the mixture begins to solidify, water is added, at first slowly with shaking, and the distillation with caustic soda is carried on in the usual manner.

The trials thus far made with this method on nitrates and fertilizers containing nitrates, have proved entirely satisfactory.

In the following table are given the results obtained by the official method and the method here described, together with the percentage of nitrogen in nitrates as determined by the Schulze-Tiemann method.

* This excellent method was worked out by Mr. Winton at my suggestion, and I take the liberty of designating it the WINTON-GUNNING-KJELDAHL method.—S. W. Johnson.

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The average of the 37 determinations by the Scovell-Jodlbauer method is 4.65 per cent., by the proposed method 4.66. The greatest discrepancy in any instance is one-tenth per cent., the average discrepancy five one-hundredths per cent. In 13 cases the proposed method gave the lower result, in 21 cases the higher result and in 3 instances both gave the same result.

	Nitrogen in Nitrates by Schulze-Tiemann.	Total Nitrogen by Scovell-Jodlbauer.	Total Nitrogen by new Method.*
Pure Potassium Nitrate	....	13.73	13.71
Commercial Nitrate of Soda	....	15.86	15.90
Tobacco Dust	....	1.76	1.71
Mixture of Ground Bone, Muriate of Potash and Nitrate of Soda	3.61	5.74	5.66
Mixture of Bone, Tankage, Dis. Bone Black, Mur. Potash and Nitrate of Soda	1.46	3.81	3.85
Mixture of Bone, Tankage, Dis. Bone Black, Sulph. and Mur. Potash, Sulph. Am. and Nitrate Soda	.63	4.15	4.07
Mixture of Bone, Tankage, Dis. Bone Black, Sulph. and Mur. Potash and Nitrate of Soda	.43	4.03	4.10
Mixture of Tankage, Dis. Bone Black, Mur. Potash and Nitrate of Soda	2.23	4.41	4.51
Mixture of Tankage, Dis. Bone Black, Wood ashes and Nitrate of Soda	1.63	3.85	3.85
Mixed Fertilizer	.56	3.82	3.86
" "	2.39	6.89	6.99
" "	.69	4.84	4.89
" "	1.55	3.45	3.47
" "	.36	3.05	3.10
" "	.86	2.70	2.65
" "	1.54	3 56	3.63
" "	.21	2.84	2.79
" "	.83	3 69	3.76
" "	.12	2.83	2.77
" "	.95	4.84	4.91
" "	.70	2.48	2.44
" "	.68	2.56	2.56
" "	.38	3.56	3.55
" "	.91	2.54	2.58
" "	2.91	5.02	4.96
" "	1.42	5.97	5.95
" "	1.65	4.86	4.96
" "	2.72	5.43	5.47
" "	.28	2.93	2.93
" "	1.28	5.68	5.66
" "	2.19	6.15	6.21
" "	.17	3.17	3.24
" "	.31	2.85	2.78
" "	.37	3.77	3.80
" "	.24	3.61	3.65
" "	.58	3.13	3.16
" "	7.38	8.44	8.49

* Winton-Gunning-Kjeldahl method.—S. W. J.

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PROTEIDS OF THE WHEAT KERNEL.

By Thomas B. Osborne and Clark L. Voorhees.

In the Annual Report of this Station for 1892, pp. 143–146, was printed a brief statement giving some results of our investigation of the wheat proteids. The full account of this work has since been published in the American Chemical Journal, Vol. 15, pp. 392–471..

The importance of wheat as a breadstuff, and the fact that its superiority over all other cereals for bread-making mainly depends on the properties of the proteids composing the gluten which wheat dough yields when cautiously washed with water, justify giving here in some detail an account of the present state of knowledge regarding the proteids of wheat.

The wheat used in our work was of two kinds. One of these, Scotch Fife, a hard spring wheat, raised in Minnesota, was obtained through the kindness of Dr. D. N. Harper, late Chemist of the Minnesota Experiment Station. It was carefully selected, free from all other varieties, and was milled under the supervision of Dr. Harper, who supplied us with samples of the various mill products, together with some of the unground wheat. Two grades of flour were used, namely, "patent flour," made from the finest and purest middlings, and "straight flour," from the coarser and less pure middlings. The "shorts," chiefly composed of the outer coating of the seeds together with adhering portions of the endosperm, was also examined. Samples of whole wheat flour were prepared as required from the wheat by grinding small quantities in the laboratory mill. The other wheat used was a variety of winter wheat known as "Fultz." This was procured from Mr. F. S. Platt, seedsman, of New Haven, and was carefully selected and freshly harvested.

When wheat flour or meal is made into a stiff dough with water and then carefully kneaded or squeezed in a gentle stream of water, the starch which makes up 60–68 per cent. of the flour or meal is gradually washed away for the most part, and there remains a tough elastic sticky mass.

The first published description of this body was made by Beccari in 1745 who gave it the name it still bears, viz: *Gluten.*

In 1805 Einhof observed that hot alcohol extracts from wheat flour a substance resembling gluten. In 1820 Taddei showed

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that gluten contains two substances, one soluble the other insoluble in boiling alcohol.

Since 1820 many chemists have undertaken to investigate gluten but their conclusions as regard the number, properties and composition of the proteids it contains are extremely discordant. Einhof, Boussingault, Bouchardat, Denis, Weyl and Bischoff and Martin have considered gluten to consist essentially of a single proteid. Berzelius, DeSaussure, Liebig, Dumas & Cahours, and Von Bibra, believed it to contain three, while Ritthausen and Bechamp regard it as composed of four proteids.

We have separated from the wheat kernel five distinct proteids, viz: Gliadin, Glutenin, a Globulin, an Albumin and a Proteose. A proteose-like body, apparently distinct, was also obtained, but in too small quantity for satisfactory examination.

The mode of isolating these substances in a state of comparative purity and establishing their individuality, is fully stated in our paper, to which reference must be made for details.

Of these proteids only the first two properly belong to gluten.

I. *Gliadin* is the proteid which is readily dissolved from wheat flour and from gluten by hot dilute alcohol. It also exists in the rye-kernel.

This substance, when dehydrated by absolute alcohol and thoroughly dried over sulphuric acid, forms a snow-white, friable mass which is easily reduced to a powder. If dried after being moistened with dilute alcohol or water it resembles, in appearance, pure gelatin. Dried thus, in thin sheets it is perfectly clear and transparent but is rather more brittle than gelatin. When treated in the cold with distilled water it becomes sticky and slightly dissolves. If the water is warmed, more dissolves and on boiling much goes into solution. Solutions in warm water on cooling deposit a part of the substance. The solution in pure water is instantly precipitated by adding a very minute amount of sodium chloride.

In absolute alcohol gliadin is entirely insoluble, but dissolves on adding water, the solubility increasing with the addition of water up to a certain point, and then diminishing. The exact degree of solubility for various strengths of alcohol has not been determined, but mixtures of about 70 per cent. of alcohol and 30 per cent. of water dissolve the proteid in almost indefinite amount. From solutions in strong alcohol as well as from those in very weak alcohol the proteid is precipitated by adding a few

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drops of solution of sodium chloride, the completeness of the precipitation depending on the strength of the alcohol and the amount of salt added. The more the alcohol varies in strength from 70–80 per cent. the more completely is the substance precipitated.

In extremely dilute acids and alkalies this proteid is readily soluble, and is precipitated from such solutions on neutralization apparently unchanged either in properties or composition.

Gliadin gives with Millon's reagent, with nitric acid and with the biuret-test, the usual proteid reactions. Dissolved in concentrated hydrochloric acid, a beautiful violet color develops slowly. With warm 50-per cent. sulphuric acid a similar color appears which is greatly increased in intensity on boiling.

On boiling its aqueous solutions, gliadin coagulates and becomes insoluble both in alcohol and in $\frac{1}{10}$ per cent. potash-solution, but is not thus converted into glutenin, the latter being soluble in weak alkali.

Gliadin was so called by Taddei because of its resemblance to glue. It has also been called plant-gelatin by Liebig and glutin by Dumas. The plant-casein of Dumas, the mucin of De Saussure and Berzelius, the gluten-fibrin and wheat-mucedin of Ritthausen are impure gliadin.

Gliadin is entirely distinct in composition from the alcohol-soluble proteids of barley, maize and oats. We found in Fife wheat, 4.33 and in Fultz, 4.25 per cent. of gliadin.

Our analyses of these gluten-proteids are as follows :

	Gliadin of wheat, average of 25 analyses.	*Gliadin* of rye, average of 13 analyses.	*Glutenin* of wheat, average of 8 analyses.
Carbon	52.72	52.75	52.34
Hydrogen	6.86	6.84	6.83
Nitrogen	17.66	17.72	17.49
Sulphur	1.14	1.21	1.08
Oxygen	21.62	21.48	22.26
	100.00	100.00	100.00

II. *Glutenin.* Characteristic reactions of a proteid body which can be dissolved only in dilute acids or alkalies are necessarily very few in number. Our preparations of glutenin after drying over sulphuric acid, were found to yield to distilled water, especially when warm, a little proteid substance. Diluted alcohol also dissolved a minute amount of proteid matter in the cold, and when heated to boiling, a much greater quantity. It is question-

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able whether the substance dissolved by water and by alcohol was not a trace of gliadin which had failed to be completely extracted in the process of preparing the glutenin. The fact that the solution in hot alcohol began to precipitate at once on cooling and that especial care had been taken in every case to remove the gliadin, makes it probable that glutenin is slightly soluble in water and in alcohol, especially if these are warmed.

In very dilute alkalies, as $\frac{1}{10}$-per cent. potash solution, and in very dilute acids, as $\frac{2}{10}$-per cent. hydrochloric acid, glutenin, after dehydration with absolute alcohol and drying over sulphuric acid, is slowly soluble, with the exception of a greater or less amount of coagulated residue, depending on the circumstances of its preparation. When freshly precipitated and in the hydrated condition it is extremely soluble in the slightest excess of caustic alkali, and in a somewhat greater but still very slight excess of acid. In this condition it is also soluble in the slightest excess of sodium carbonate solution or ammonia. After drying over sulphuric acid it dissolves partly in $\frac{5}{10}$-per cent. sodium carbonate solution.

Dissolved in concentrated hydrochloric acid it gives a solution slightly yellowish at first, but becoming a deep violet color on standing. In sulphuric acid diluted with an equal volume of water the solution is brownish in color after boiling, and remains clear when diluted. The undiluted solution, on standing, retains its brown color.

A comparison of the analyses of glutenin with those of gliadin shows a very close agreement of the two in composition. As it is well known that many proteids readily lose their solubility, without change of composition detectable by analysis, it might seem proper to consider this body as an altered and insoluble gliadin.

There is, however, no evidence that gliadin is actually transformed into glutenin, and since very recent investigation shows that rye-grain contains gliadin but probably not glutenin, it would appear that the two are to be regarded as distinct.

This proteid, in an impure state, has been termed by various investigators zymom, plant-fibrin, gluten-casein and gluten-fibrin. As all these names are associated with confused and erroneous notions as to its composition, origin and properties, they are all properly discarded in favor of the new designation glutenin.

In Fife wheat we found 3.96 and in Fultz 3.91 per cent. of glutenin. The other proteids in the wheat kernel are :—

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III. *Edestin*,* a *globulin* belonging to the vegetable vitellins, soluble in saline solutions, precipitated therefrom by dilution and also by saturation with magnesium sulphate or ammonium sulphate, but not by saturation with sodium chloride. Partly precipitated by boiling, but not coagulated at temperatures below 100°. The wheat kernel contains between 0.6 and 0.7 per cent. of this globulin. When dried at 110° its composition was found to be as below stated.

IV. *Leucosin*,† an *albumin*, coagulating at 52°, unlike animal albumin in being precipitated on saturating its solutions with sodium chloride or magnesium sulphate. It is not precipitated on completely removing salts by dialysis in *distilled* water. It was found to form between 0.3 and 0.4 per cent. of the wheat kernel, and to have the following composition when separated from solution in the coagulated form by heating to 60° C. :

	Edestin.	*Leucosin*, coagulated.	*Coagulum* from Proteose.
Carbon	51.03	53.02	51.86
Hydrogen	6.85	6.84	6.82
Nitrogen	18.39	16.80	17.32
Sulphur	0.69	1.28	24.00
Oxygen	23.04	22.06	
	100.00	100.00	100.00

V. A *proteose*, precipitated (after removing the globulin by dialysis, and the albumin by coagulation) by saturating the solution with sodium chloride, or by adding 20 per cent. of sodium chloride and acidifying with acetic acid. This body was not analyzed in its unaltered form. On concentrating its solutions by boiling, a *coagulum* was gradually developed which formed about 0.3 per cent. of the wheat kernel and had the composition given above.

VI. The solution filtered from the substance just described (V.), still contained a *proteose-like body* which was not obtainable in a pure state. Its amount could only be roughly estimated by precipitating the concentrated filtrate from the preceding substance with alcohol, and multiplying the nitrogen contained in the precipitate by 6.25. The amount of this proteose was from 0.2 to 0.4 per cent. of the seed. Both this proteose and the above coagulum are unquestionably derivatives of some other proteid in the seed, presumably the proteose first mentioned.

* Ἐδεστὸς, edible. † Λευκὸς, white.

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The Formation of Gluten.

Wheat, so far as is known, is the only plant whose seeds contain proteid matter separable in a coherent form from the other constituents by washing with water. When ground fine and mixed with a suitable quantity of water it yields a dough from which a light, porous bread can be made. The importance of this fact in bread-making is so great that considerable attention has been paid to gluten by the chemists who have studied wheat proteids.

The investigations of Günsberg and of Martin, as well as our own, disprove the existence of gluten-fibrin and mucedin, which are currently stated to exist in gluten, and demonstrate that, as Taddei maintained, gluten consists of two proteids only.

Weyl and Bischoff have asserted* that the proteid matter of the wheat kernel is *chiefly a globulin substance*, and that in contact with water it undergoes a change, presumably through the influence of a ferment, by which gluten is first produced.

The statements of these investigators are not sustained by any sufficient evidence. They say: "On investigating the proteids of wheat meal, one of us found principally a globulin substance, which he designated, in consequence of its similarity to myosin of the muscle, *vegetable myosin*. This vegetable myosin must be the mother-substance of the gluten, since in the wheat meal, together with it, other proteids, if at all, exist only in very small amount." What the reasons were for concluding that the "myosin" constitutes nearly if not all the proteid of the wheat kernel does not appear. In view of our results this statement is certainly erroneous. Direct treatment of the meal with alcohol yields extracts containing gliadin in exactly the same amount as obtained from the gluten made from an equal quantity of flour, and extraction of either flour or gluten with alcohol, after complete exhaustion with sodium chloride solution, also gives the same proportion of gliadin. This substance must therefore exist in the seed, having the same composition and properties as in the gluten, and as it forms one-half of the gluten, it leaves the other half only as possibly derived from a globulin body through the influence of a ferment. If Weyl and Bischoff's view were correct, treatment of the flour with 10-per cent. salt solution ought to alter the character and quantity of the gluten obtained, if not

* Ber. d. deutsch. Chem. Gesell., 1880, 367.

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altogether to prevent its formation. This is not so, for the usual amount of gluten can readily be obtained from flour made into dough with 10-per cent. sodium-chloride solution and then washed with the same until starch is removed.

Weyl and Bischoff next state that, "with the aid of a 15-per cent. rock-salt solution the flour was extracted until no proteid could be detected in the extract; the residue of the meal kneaded with water then gave no gluten. *If the globulin substance be extracted no formation of gluten takes place.*" We have found that this is true if the flour is stirred up with a large quantity of salt solution, extracted repeatedly with fresh quantities of the same solution until no more proteid is dissolved, and the excess of solution removed by allowing the residue to drain on a filter as completely as possible. If, however, wheat flour is mixed at first with just sufficient salt solution to make a firm dough, this dough may then be washed indefinitely with salt solution, and will yield gluten as well and as much, as if washed with water alone. This difference is due to the fact, that when large quantities of salt solution are applied at once, the flour fails to unite to a coherent mass and cannot afterwards be brought together, as is possible when treated with smaller quantities of solution.

Weyl and Bischoff compare the formation of gluten to that of blood-fibrin from fibrinogen under the influence of a ferment. They say that the formation of gluten is affected by all the conditions which interfere with the activity of ferments in general. "Large amounts of salt hinder the formation of gluten. Sulphates of magnesium and sodium behave like common salt." These statements are explained by what has been said above.

They tried unsuccessfully to obtain the supposed ferment in the following manner:

"We allowed meal with an equal weight of 90-per cent. alcohol to stand in closed vessels different lengths of time (in one case four months, then several times 3 to 4 weeks, frequently only 8 to 10 days). The vessels were repeatedly shaken and the yellow-colored alcoholic extract was poured off. The residue was freed from alcohol by pressing and evaporating at the ordinary temperature. After it was stirred up with water, little or no gluten was obtained. Evidently the globulin substance had been coagulated for the most part by the alcohol." It is clear that if the flour were thus treated, the greater part of the gliadin would be removed. We have found that if flour be extracted

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with dilute alcohol until the gliadin is removed, and the residue freed from alcohol by exposure to the air, the latter will then yield no gluten when treated with water.

More recently Sidney Martin has advanced a somewhat similar theory of the formation of gluten from the proteids contained in the seed. He states* that alcohol extracts from gluten but one proteid substance; that this is soluble in hot water but not in cold, and he therefore calls it an *insoluble phytalbumose.*

The residue of the gluten not dissolved by alcohol is uncoagulated proteid, if the alcohol has not been allowed to act too long. This substance he names *gluten-fibrin.* Martin further says that gluten dissolves almost completely in $\frac{2}{10}$-per cent. hydrochloric acid, or $\frac{2}{10}$-per cent. potash solution, leaving a small residue of fat. The solution gives a copious precipitate when neutralized, but the supernatant liquid still contains a quantity of proteid which is the dissolved insoluble albumose. The whole of the gluten-fibrin is reprecipitated by neutralization, that is, it is wholly converted into an "albuminate."

Martin then asks: "Does flour contain gluten-fibrin? Does it contain insoluble phytalbumose?" The first question he says cannot be answered directly. "The second is answered by extracting flour with 76–80 per cent. alcohol. This ought to contain the insoluble albumose if it were present as such in the flour, *but it does not contain it;* it extracts only fat." This statement is contrary to our experience, for we have never failed, in many experiments, thus to extract this substance (gliadin) from the flour, and that too in the same amount and of the same properties and composition as from the gluten.

Martin concludes that insoluble albumose is not present as such in the flour. He then says: "Before proceeding to mention its precursor, it will be well to state that 10-per cent. sodium-chloride solution extracts from flour a large quantity of globulin and of albumose. This globulin is of the myosin type, coagulating between 55° and 60° C., and precipitated by saturation with sodium chloride and ammonium sulphate. Both the globulin and albumose are present in a much smaller quantity in the watery extract of the flour." From this it is evident that Martin has fallen into the same error as Weyl and Bischoff, mistaking the albumin for a myosin-like globulin, and being greatly misled as to its amount.

* British Med. Jour., 2, p. 104 (1886).

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Continuing, Martin says: "The direction of the evidence is to show that the insoluble albumose is formed from the soluble. Moreover, I think that the globulin is transformed into the gluten-fibrin, for I have been able to obtain from the globulin in solution a body having the same reactions as the gluten-fibrin." What this evidence is, which, by its direction, shows that the insoluble albumose is derived from the soluble, is not clear, and Martin makes no further statements on this point. That a body should be obtained from the solution containing the globulin which had the same reactions as the "gluten-fibrin" is not surprising, for the so-called "albuminates" derived from nearly all globulins have no characteristic reactions, being merely soluble in dilute acids and alkalies, and precipitated by neutralization in the same way as "gluten-fibrin." Martin then states his theory of the formation of gluten in the following scheme:

$$\text{Gluten} = \begin{cases} \text{Gluten-fibrin} & \text{—precursor, globulin.} \\ \text{Insoluble albumose} & \text{—} \quad \text{“} \quad \text{soluble albumose.} \end{cases}$$

This cannot be a correct representation of the formation of gluten, for it has been shown to be founded on two erroneous observations: first, that alcohol does not extract proteid matter from the flour when applied directly, and second, that at least one-half the proteid matter of the seed is a myosin-like globulin.

The results obtained by us and described at length in our paper* lead to the conclusion that no ferment-action is involved in the formation of gluten; that but two proteid substances are contained in the gluten, gliadin and glutenin, and that these exist in the wheat kernel in the same form as in the gluten, except that in the latter they are combined with water in an amount equal to about twice the weight of the water-free proteids. The reasons for this opinion are, first, that alcohol extracts the same gliadin in the same amount, whether applied directly to the flour, to the gluten, or to the flour previously extracted with 10-per cent. sodium-chloride solution; second, that $\frac{2}{10}$-per cent. potash extracts glutenin of uniform composition and properties from flour which has been extracted with alcohol or with 10-per cent. sodium-chloride brine and then with alcohol, as well as from gluten which has been exhausted with alcohol.

Both glutenin and gliadin are necessary for the formation of gluten, as shown by the three following experiments.

* Am. Chem. Jour., 15, 392–471.

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1. A portion of flour was washed completely free from gliadin by means of alcohol of 0.90 sp. gr., next with stronger alcohol, finally with absolute alcohol, and air-dried. The residue was then rubbed up fine until all lumps were removed, and water carefully added and a dough made of the mass. A tolerably coherent dough was thus obtained, but much less elastic and tough than that produced from the untreated flour. This dough was then washed with water on a sieve, using every precaution to obtain a gluten, but none was formed.

2. Again, 7.5 grams of very finely ground air-dried gliadin were mixed intimately with 70 grams of fine corn-starch and distilled water added. A plastic dough was thus produced, but it had no toughness. On adding a little 10-per cent. sodium-chloride solution, the dough became at once tough and elastic. This was then washed with great care on a sieve with cold water, a little 10-per cent. salt solution being added from time to time, but in spite of every precaution no gluten was obtained.

3. The following experiment shows that the gliadin used was capable of forming gluten when glutenin was present, and also that salts have a marked influence on the toughness of wheaten dough.

Two portions of flour, weighing 100 grams each, were taken, and after adding 5 grams of gliadin to one, both were made into dough with the same quantity of water. The two doughs presented marked differences; that to which the gliadin had been added was much tougher and more yellow than the other. They were then washed with water as long as starch separated. The gluten was dried superficially by wiping with a cloth and weighed in the moist state. That from 100 grams of flour to which 5 grams of gliadin had been added weighed 44.55 grams; that from 100 grams of flour alone weighed 27.65 grams. The moist glutens were dried at 110° to constant weight, and both yielded the same proportion of dry gluten, viz., 34.6 per cent. The yield of dry gluten was accordingly, in the first case 15.41 grams, and in the second 9.56 grams. The difference, 5.85 grams, shows that the added gliadin was fully recovered in the gluten.

The above figures show that these proteids combine with about twice their weight of water in forming gluten. The fact that the added gliadin entered so readily and completely into the formation of gluten indicates that it exists in the seed as such and undergoes no chemical change during extraction and drying.

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The properties observed in testing the separated gliadin show how it acts in forming gluten, and explain many of the points observed by others and attributed to a ferment-action.

When treated with distilled water in small amount the fine ground air-dry gliadin at once forms a sticky mass which, on adding more distilled water, dissolves to a turbid solution. If, however, a very little sodium chloride is added to distilled water and this applied to gliadin that has been first moistened with pure water, a very coherent, viscid mass results which adheres to everything it touches and can be drawn out into long threads. If the gliadin is moistened with 10-per cent. sodium-chloride solution and then treated with a larger quantity of this solution, the substance unites to a plastic mass which can be drawn out into sheets and strings, but is not adhesive. From this it is evident why Ritthausen, in washing flours which gave a fluid gluten obtainable only in small quantity and with great difficulty, found that the addition of calcium sulphate to the wash-water rendered the gluten much more coherent and easily obtainable. The gliadin is thus proved to be the binding material which causes the particles of flour to adhere to one another, in forming a dough.

But the gliadin alone is not sufficient to form gluten, for it yields a soft and fluid mass which breaks up entirely on washing with water. The insoluble glutenin is probably essential by affording a nucleus to which the gliadin adheres and from which it is not mechanically carried away by the wash-water.

It might be supposed that this insoluble glutenin which so nearly resembles gliadin in composition results from an alteration of the latter brought about by the action of the mineral or other constituents of the seed or of the water. This is not probable, for the same amount of gliadin is extracted from flour directly by treating it with alcohol of 0.90 sp. gr. as is obtained from the gluten itself, and also the same amount is obtained after extracting the flour completely with 10-per cent. sodium-chloride solution and then with alcohol.

The behavior of the gliadin towards 10-per cent. sodium-chloride solution shows why no gluten was obtained by Weyl and Bischoff from flour extracted with this solvent. The gliadin had under these conditions no adhesive qualities and therefore was unable to bind the flour into a coherent mass. If, however, the salt solution is added in small quantities and the flour kneaded and pressed, the particles are brought together and then adhere tenaciously.

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THE PROTEIDS OF THE KIDNEY BEAN,

(*Phaseolus Vulgaris*,)

BY

THOMAS B. OSBORNE.

The only work on the proteids of the kidney bean having importance at the present time, is that of Ritthausen. This investigator in 1883, stated* that the extract of the white bean which has a weak alkaline reaction, and is extremely difficult to filter, when made clear by subsidence, yields on adding acetic acid, a voluminous precipitate, amounting to about 11 per cent. of the seed, having the following composition:—

Carbon	51.48
Hydrogen	7.04
Nitrogen	14.40
Sulphur	0.42
Oxygen	26 66
	100.00

In 1884, Ritthausen† published the results of further study of this seed. He then stated that the proteid, obtained in his earlier experiments, was wholly insoluble in 5 per cent. sodium chloride solution, but partially dissolved in 2 per cent. brine, and by diluting was precipitated in a form entirely like the original substance. By treating the bean meal with alcohol he found that clarification of the extracts was greatly facilitated and he therefore used meal so treated in his subsequent experiments.

By extraction with 2 per cent. sodium chloride solution, and clearing the extract by subsidence, he obtained, in two cases, precipitates of proteid, amounting respectively to 13.2 and 11.45 per cent. of the meal. Another preparation, equal to 8.67 per cent., he obtained from an aqueous extract of the meal precipitated with hydrochloric acid, the precipitate being redissolved in potash-water and the solution neutralized after filtering clear. By extracting the bean meal with dilute hydrochloric acid, he obtained 10.07 per cent. of proteid. Preparations made by precipitating aqueous solutions with hydrochloric acid and sodium chloride extracts by dilution and submitting the precipitates to

* Jour. f. prakt. Chem., **103**, 204.

† Jour. f. prakt. Chem. n. folge, **29**, 452.

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analysis without re-solution and consequent purification, had a composition similar to that found for the earlier preparations.

The precipitate obtained from hydrochloric acid solutions, had a different composition, agreeing with that of the proteid extracted by dilute salt solution both from the older preparations and from the freshly formed precipitate produced by acids in the aqueous extract, as well as with that of the insoluble portion remaining after this extraction, and also with that of the precipitate produced by hydrochloric acid in the aqueous extract, redissolved in dilute potash-water and precipitated by neutralization. An average of five quite closely agreeing analyses of the proteid thus obtained, is shown by the following figures:—

Carbon	52.55
Hydrogen	7.09
Nitrogen	16.18
Sulphur	0.43
Oxygen	23.75
	100.00

This proteid, Ritthausen remarked, "is so similar in composition to albumin, that one might be led to regard it as an albumin, low, indeed, in sulphur." In most respects the experiments of the writer now to be detailed, confirm these observations of Ritthausen, but in two particulars his statements have not been corroborated. The reaction of the aqueous extract, I have found in all cases, to be distinctly acid, even when the beans were tested within two minutes after crushing. Ritthausen's statement that his earlier preparations were wholly insoluble in 5 per cent. solution of sodium chloride, while a very considerable quantity was dissolved by 2 per cent. brine, is difficult to understand, unless as implied, though not directly so expressed, the presence of the proteid was detected by largely diluting the salt-water extracts. The writer has found that strong saline solutions, unless containing a large proportion of this proteid, are not precipitated by dilution, the salt being present in sufficient quantity to serve as a solvent for the diminishing percentage of the dissolved proteid.

I have been able to identify and obtain in a state of comparative purity, two distinct proteids, one, the most abundant, having quite the properties of a globulin, which I shall designate *phaseolin* and another, not so definite in character, that may be distinguished as *phaselin*.

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Preparation of Phaseolin.

An extract was prepared by treating 500 grams of freshly ground bean meal,* which had been previously exhausted with ether, with one liter of 2 per cent. sodium chloride solution. The residue was strained out on coarse linen, squeezed dry in a screw press, and again treated with a liter of the 2 per cent. salt solution. The resulting extract filtered very slowly and not wholly clear; about nine-tenths of it was finally obtained as a turbid filtrate. This was saturated with ammonium sulphate and the precipitate produced, collected on a filter and separated as completely as possible from the solution. This precipitate was removed from the filter and treated with water. Much of the substance went into solution, but a considerable part remained undissolved. After 24 hours filtration, a very nearly clear liquid was obtained, amounting to about two-thirds of the solution. This was then dialyzed in a stream of river water for six days. When thus freed from chlorides, the contents of the dialyzer were transferred to a filter, but only a part of the separated proteid remained on the paper, the filtrate being milky. The precipitate collected was washed with water, alcohol and ether, and when dried over sulphuric acid, weighed 16 grams. This preparation had the following composition :—**1.**

Phaseolin, *Preparation* 1.

	I.	II.	Average.	Ash-free.
Carbon	51.73	....	51.73	52.23
Hydrogen	6.89	....	6.89	6.95
Nitrogen	16.28	16.14	16.21	16.37
Sulphur	0.68	0.54	0.61	0.62
Oxygen	....	....	....	23.83
Ash	0.96	....	0.96	....
				100.00

As this preparation separated from a not perfectly clear solution, and therefore, presumably, was impure, a part of it was dissolved in 1 per cent. sodium chloride brine and precipitated by dilution. After standing a few hours to settle, the precipitate was filtered off and washed with distilled water, with alcohol and with ether. Its composition is as follows:—**2.**

* The "White Medium Field Bean," the seeds being about $\frac{3}{4}$ inch or 1^{cm} in length, was used for this investigation.

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PHASEOLIN, *Preparation* 2.

		Ash-free.
Carbon	52.35	52.60
Hydrogen	6.63	6.69
Nitrogen	16.42	16.56
Sulphur	0.63	0.63
Oxygen	----	23.52
Ash	0.82	----
		100.00

Another preparation was made by treating the fine ground beans, previously extracted both with ether and alcohol, with 10 per cent. sodium chloride solution, as long as any proteid was removed. The extract was allowed to stand over night and the very nearly clear, greenish-yellow liquid was decanted from the sediment and saturated with ammonium sulphate. The precipitated proteid was collected on a filter and dissolved in dilute salt solution. This liquid was filtered as clear as possible and then dialyzed. When freed from chlorides, the globulin which had separated was filtered off, and washed and dried in the usual manner. This preparation, 3, had the following composition:—

PHASEOLIN, *Preparation* 3.

	I.	II.	Average.	Ash-free.
Carbon	52.19	----	52.19	52.60
Hydrogen	6.67	----	6.67	6.72
Nitrogen	16.01	16.06	16.04	16.17
Sulphur	0.63	----	0.63	0.63
Oxygen	----	----	----	23.88
Ash	0.79	----	0.79	----
				100.00

As this preparation, 3, separated from a solution which could not be filtered perfectly clear, it is undoubtedly impure. In order to determine whether the preparations thus far obtained were mixtures of two or more globulins, the following were made by fractionally precipitating the extracts. The extraction was also carried out in such a way as to afford an approximate determination of the amount of phaseolin contained in the extracts.

100 grams of bean meal were treated with 500^{cc} of 1 per cent. sodium chloride solution, strained through cloth, and allowed to stand so as to deposit most of the suspended matter. The solution was then decanted and 350^{cc} of nearly clear extract obtained, being therefore approximately seven-tenths of the whole. This solution was then diluted with 1050^{cc} of distilled water and allowed to stand until the precipitate so produced had settled.

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The latter was collected on a filter, washed with alcohol and ether, and when air dried was found to weigh 4.76 grams; preparation **4**. The filtrate from **4** was diluted with about an equal bulk of water and carbon dioxide was passed through it. After standing some time, a precipitate settled out, leaving the liquid nearly clear. This was decanted and the precipitate collected on a filter and treated like **4**. This gave preparation **5**, which weighed 3.76 grams. The filtrate from **5** was further diluted with a considerable quantity of water and carbon dioxide again passed through the solution. This gave preparation **6**, weighing, air dry, 1.12 grams. The filtrate from **6** was treated with acetic acid, and a further small precipitate, **7**, obtained, weighing 0.7 gram. The four preparations together weighed 10.34 grams, and as they were obtained from seven-tenths of the total extract, were approximately equivalent to the proteid derived from 70 grams of air dry bean meal or to 14.77 per cent. of the meal. It is evident that in preparing the globulin by dialysis in the manner just described, only a part was obtained. As preparation **4** was separated from an unfiltered extract, it was necessary to dissolve and reprecipitate it before submitting it to analysis. It was accordingly treated with 1 per cent. sodium chloride solution, but had become largely insoluble in brine. The insoluble matter was filtered off, the clear filtrate diluted, and carbon dioxide passed through it as long as globulin was precipitated.

The precipitate was filtered off, washed thoroughly with water, alcohol and ether and dried over sulphuric acid. Only 1 gram of proteid, preparation **4**, was recovered.

PHASEOLIN, *Preparation* **4**.

	I.	II.	Average.	Ash-free.
Nitrogen	16.05	15.89	15.97	16.12
Ash	0.93	....	0.93	....

Analyses of the other preparations gave the following results:—

PHASEOLIN, *Preparation* **5**.

	I.	II.	Average.	Ash-free.
Carbon	52.14	....	52.14	52.54
Hydrogen	6.78	....	6.78	6.83
Nitrogen	16.35	....	16.35	16.48
Sulphur	0.62	0.53	0.58	0.58
Oxygen	....	....	....	23.57
Ash	0.77	....	0.77	....
				100.00

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PHASEOLIN, *Preparation* 6.

		Ash-free.
Nitrogen	15.82	16.23
Ash	2.51	----

PHASEOLIN, *Preparation* 7.

		Ash-free.
Nitrogen	16.70	16.87
Ash	1.04	----

A larger quantity of meal was next extracted, and the extract fractionally precipitated in the following manner:

500 grams of meal were treated with 1500^{cc} of 1 per cent. sodium chloride solution, and the extract filtered once through good filter paper. About two-thirds of the extract were thus obtained as a turbid solution. Three volumes of distilled water were added, and the large precipitate formed was designated A. Through the filtrate from A, a current of carbonic acid gas was passed, and the resulting precipitate filtered off and marked B. Precipitate A was treated with about 50^{cc} of 10 per cent. sodium chloride brine and filtered as well as possible. A considerable part of A had become insoluble, and the filtration was exceedingly slow. After two and one-half days, most of the solution had filtered very nearly clear. This was then diluted with about ten times its volume of water, and the precipitate thereby produced, filtered off, washed with alcohol and ether, and dried over sulphuric acid; preparation **8**. The filtrate from **8** was again diluted with a large quantity of water and a second precipitate obtained in a like manner; preparation **9**.

The filtrate from **9** gave a very small additional precipitate with carbon dioxide, weighing when dry, only 0.2 gram. A portion of precipitate B was dried and marked preparation **10**. Five grams of precipitate B were dissolved in ½ per cent. sodium chloride solution, previously heated to 70°, filtered hot from the considerable insoluble matter, an equal volume of water heated to 70° was added to the filtrate, and the solution very slowly cooled. The proteid separated in well-developed spheroids. When this precipitate was filtered off and washed with water, the substance began to dissolve, as the salts were washed out, in the same way as the globulins of the oat kernel, castor bean and hemp-seed dissolve, when they are washed with water, after separating from warm salt solutions on cooling. Alcohol was then added to the contents of the funnel, and the substance washed with alcohol and ether, and dried. This preparation **11**, weighed 2 grams.

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The insoluble proteid filtered from the solution which yielded **11**, was dissolved in $\frac{2}{10}$ per cent. potash-water and after filtering, the solution was exactly neutralized with $\frac{2}{10}$ per cent. hydrochloric acid. The precipitate, which was very readily soluble in dilute sodium chloride solution, after washing with water, alcohol and ether, and drying, weighed 0.65 gram; preparation **12.**

Another portion of precipitate B weighing 3.35 grams, was treated with $\frac{1}{2}$ per cent. sodium chloride brine, and heated to 70°. The insoluble matter was filtered off, washed with hot dilute salt solution, with water, alcohol and ether, and when dried formed preparation **13,** weighing 1.16 gram. The dissolved proteid separated from the filtrate and washings of **13** on gradually cooling, and after washing with dilute alcohol, absolute alcohol and ether, gave 1.54 grams of preparation **14.** All were then dried at 110°, and analyzed with the following results:—

PHASEOLIN, *Preparation* **8.**

	I.	II.	Average.	Ash-free.
Carbon	52.31	....	52.31	52.72
Hydrogen	7.18	....	7.18	7.24
Nitrogen	16.32	16.32	16.32	16.45
Sulphur	0.67	0.66	0.67	0.67
Oxygen	....	....	....	22.92
Ash	0.80	....	0.80	....
				100.00

PHASEOLIN, *Preparation* **9.**

		Ash-free.
Carbon	51.89	52.35
Hydrogen	6.83	6.89
Nitrogen	16.37	16.52
Sulphur } Oxygen }	....	24.24
Ash	0.88	....
		100.00

PHASEOLIN, *Preparation* **10.**

	I.	II.	Average.	Ash-free.
Carbon	51.89	51.98	51.94	52.74
Hydrogen	6.84	6,64	6.74	6.84
Nitrogen	16.40	....	16.40	16.65
Sulphur	0.63	....	0.63	0.64
Oxygen	....	....	....	23.13
Ash	1.52	....	1.52	....
				100.00

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PHASEOLIN, *Preparation* 11.

		Ash-free.
Carbon	52.34	52.49
Hydrogen	6.78	6.80
Nitrogen	16.80	16.85
Sulphur } Oxygen }	----	23.86
Ash	0.36	----
		100.00

PHASEOLIN, *Preparation* 12.

		Ash-free.
Nitrogen	16.54	16.67
Ash	0.81	----

PHASEOLIN, *Preparation* 13.

		Ash-free.
Carbon	52.76	53.06
Hydrogen	6.81	6.85
Nitrogen	16.59	16.68
Sulphur } Oxygen }	----	23.41
Ash	0.57	----
		100.00

PHASEOLIN, *Preparation* 14.

		Ash-free.
Carbon	52.12	52.49
Hydrogen	6.68	6.73
Nitrogen	16.33	16.45
Sulphur } Oxygen }	----	24.13
Ash	0.72	----
		100.00

These results show that the greater part of the proteid extracted by sodium chloride solution, consists of a single globulin, amounting at least to 15 per cent. of the seed. The greater part of the proteid remaining in the seed after extraction with salt solution, is presumably the same globulin, possibly inclosed in the tissue of the coarsely ground seed, so that it was not reached by the salt solution, or more likely, an insoluble or "albuminate" form of this globulin, as the following experiment indicates. After complete exhaustion with 10 per cent. sodium chloride brine, of the meal from which preparation 3 was obtained, the residue was extracted with $\frac{2}{10}$ per cent. potash water, the extract allowed to stand over night and then decanted and precipitated with hydro-

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chloric acid, added in very slight excess. The precipitate was washed by decantation, redissolved in potash water and filtered clear. This solution was then precipitated by hydrochloric acid, and as the proteid separated imperfectly, it was treated with alcohol and ether, and filtered off. After washing with dilute alcohol, absolute alcohol and ether, it was dried and analyzed; preparation **15.**

PHASEOLIN, *Preparation* **15.**

		Ash-free.
Carbon	51.57	52.47
Hydrogen	6.78	6.90
Nitrogen	15.71	16.00
Sulphur } Oxygen }	....	24.63
Ash	1.72	....
		100.00

Another preparation of the globulin was made by treating 100 grams of bean meal, previously extracted with ether, with 500 cc. of *distilled water*, straining through a cloth, allowing the extract to stand over night to deposit suspended matter and decanting the slightly turbid liquid, of which the 250 cc. thus obtained were diluted to 2000 cc. and treated with a current of carbonic acid gas. On standing, the considerable precipitate settled out so that the solution could be filtered. The precipitate was washed with water, alcohol, and ether, and when dried over sulphuric acid weighed 5.5 grams. As the extract employed measured one-half the volume of the water applied to the meal, the yield of globulin was in this case approximately 11 per cent. of the bean meal. Although precipitated from a somewhat turbid solution, and consequently not quite pure, this preparation was analyzed with the following results:—

PHASEOLIN, *Preparation* **16.**

	I.	II.	Average.	Ash-free.
Carbon	52.48	52.49	52.49	53.22
Hydrogen	6.71	6.86	6.79	6.86
Nitrogen	16.32	16.18	16.25	16.48
Sulphur	0.45	0.48	0.47	0.48
Oxygen	....	....	....	22.96
Ash	1.53	1.27	1.40	....
				100.00

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It is evident from this analysis that the principal proteid extracted by water, is the same as that extracted by saline solutions, and as this substance is precipitated from the aqueous extract by dilution, it is undoubtedly dissolved by aid of the salts contained in the beans. It is not probable that the acid contained in the seed, causes this solution, for in that case the proteid would not be precipitated by dilution, a considerable excess of acid being necessary to effect its precipitation. The meal after extracting with water, as just described, was treated with 1 per cent. sodium chloride solution, the extract filtered, largely diluted with water, and charged with carbon dioxide. Only a trifling precipitate resulted which, when prepared in the usual manner, weighed 0.52 grams. This preparation, **17**, ash-free, contained 16.29 per cent. of nitrogen. These results show that nearly, if not quite as much of the globulin is extracted by water with help of the salts of the seed, as by use of stronger salt-solutions.

Another portion of the bean-meal was extracted with a considerable quantity of 1 per cent. sodium chloride solution, the extract was filtered as clear as possible, and dialyzed in a large vessel containing alcohol. The globulin readily separated after a short time, in well formed tetrahedral crystals mixed with amorphous matter. This precipitate was filtered off, treated for 48 hours with a 1 per cent. sodium chloride solution, filtered clear and again precipitated by dialysis in alcohol, at first quite dilute, but afterwards of gradually increased strength. The substance now separated in large well formed tetrahedral crystals, the edges of which were slightly curved. This precipitate was filtered off, washed with water, alcohol and ether, dried and analyzed with results as follows :—

PHASEOLIN, *Preparation* **18**. CRYSTALS.

	I.	II.	Average.	Ash-free.
Carbon	50.98	....	50.98	52.70
Hydrogen	6.56	....	6.56	6.78
Nitrogen	16.21	16.10	16.16	16.71
Sulphur	0.33	0.29	0.31	0.32
Oxygen	....	....	....	23.49
Ash	3.27	....	3.27	....
				100.00

As dilute acids precipitate proteid substance when added to the sodium chloride extracts of the ground beans, it was thought desirable to make some preparations by this method. Accord-

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ingly an extract was prepared by treating the meal with 1 per cent. sodium chloride solution, and after clearing as completely as possible by subsidence and decantation, $\frac{2}{10}$ per cent. hydrochloric acid was added until a considerable precipitate resulted. After standing some hours the precipitate was filtered off, dissolved in very dilute brine, filtered clear and precipitated by dilution. Only a small part of the substance separated. This preparation, **19**, was then washed with water, alcohol and ether, dried and found to contain ash-free, 16.71 per cent. of nitrogen.

The filtrate from **19**, when greatly diluted, gave a further precipitate, which, when filtered off and washed with water, alcohol and ether had the following composition :—

PHASEOLIN, *Preparation* **20**.

		Ash-free.
Carbon	51.85	52.20
Hydrogen	6.91	6.95
Nitrogen	16.15	16.26
Sulphur	0.51	0.51
Oxygen	----	24.08
Ash	0.68	----
		100.00

It is evident that the same globulin was obtained by this method as by those previously followed. Next to be noticed are two preparations of phaseolin, made by diluting the sodium chloride extracts in the manner already described, redissolving the precipitates first obtained in salt solution, and again precipitating by dilution. Preparation **21**, contained ash-free 16.65 per cent. of nitrogen.

PHASEOLIN, *Preparation* **22**.

	I.	II.	Average.	Ash-free.
Carbon	52.24	----	52.24	52.55
Hydrogen	6.86	----	6.86	6.90
Nitrogen	16.03	16.06	16.05	16.14
Sulphur	0.58	----	0.58	0.58
Oxygen	----	----	----	23.83
Ash	0.58	----	0.58	----
				100.00

The filtrate from **22** was then treated with $\frac{2}{10}$ per cent. hydrochloric acid, until a considerable precipitate resulted. This was filtered off, washed with water, alcohol and ether, and analyzed with the following results:—

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PHASEOLIN, *Preparation* **23.**

		Ash-free.
Carbon	51.34	52.12
Hydrogen	6.59	6.70
Nitrogen	15.96	16.21
Sulphur	0.58	0.59
Oxygen	....	24.38
Ash	1.48	....
		100.00

One more preparation of this globulin was made with special reference to its purity. For this purpose a considerable quantity of the globulin was precipitated from a 1 per cent. sodium chloride extract of the beans, and after filtering off, was twice dissolved in dilute sodium chloride solution and precipitated by dilution after filtering clear. The final precipitate was thoroughly washed with water, alcohol and ether and analyzed. When dried over sulphuric acid, the preparation was readily soluble in dilute sodium chloride solution, and consisted entirely of the unaltered phaseolin. Its composition is shown by the analysis of preparation **24.**

PHASEOLIN, *Preparation* **24.**

	I.	II.	Average.	Ash-free.
Carbon	52.45	52.52	52.49	52.75
Hydrogen	6.99	6.80	6.90	6.95
Nitrogen	16.52	16.39	16.46	16.57
Sulphur	0.56	0.44	0.50	0.50
Oxygen	....	....	....	23.23
Ash	0.69	....	0.69	....
				100.00

The properties of phaseolin as shown by careful examination of preparation **24,** dried over sulphuric acid, are as follows:

In cold or warm distilled water it is entirely insoluble.

In sodium chloride solution, and in very dilute acids and alkalies, it is very readily soluble to a clear solution.

Dissolved in 10 per cent. sodium chloride solution, it is not precipitated by acetic, hydrochloric, nitric or sulphuric acids, added in either minute or considerable quantities, although when dilute hydrochloric acid is added to the 1 per cent. sodium chloride extract of the beans, the phaseolin is precipitated.

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Dissolved in large proportion in 10 per cent. sodium chloride solution, the proteid is precipitated by adding much pure water.

Solutions of phaseolin in brine are completely precipitated by saturation with ammonium sulphate, but only slightly by saturation with magnesium sulphate or sodium chloride.

Potassium ferrocyanide and acetic acid together, give a precipitate.

With copper sulphate and caustic potash, the usual violet coloration is obtained, and with nitric acid, the xanthoproteic reaction.

Dissolved in 10 per cent. sodium chloride solution and heated very slowly in a double water bath, no turbidity occurs until the temperature is raised to 95°. This turbidity slowly increases as the temperature approaches 100°, and after some time, a flocculent precipitate begins to develop, which even after heating for an hour is but slight.

Like other plant-globulins, phaseolin separates from warm concentrated solutions on cooling, and from salt solutions on dialysis, in the form of spheroids.

The striking resemblance in composition of this proteid to the "myosins" found in the seeds of maize and oats, and also to animal myosin, is shown in the following table:—

	Phaseolin.	Maize-myosin.*	Oat-myosin.†	Animal-myosin.‡
Carbon.....	52.58	52.68	52.34	52.82
Hydrogen ...	6.84	7.02	7.21	7.11
Nitrogen	16.48	16.82	16.88	16.77
Sulphur	0.56	1.30	0.88	1.27
Oxygen.....	23.54	22.18	22.69	21.93
	100.00	100.00	100.00	100.00

The four proteids, although having many properties in common, as well as a similar composition, are yet characterized by differences so considerable, as to leave no doubt of the individuality of each.

The maize-myosin and animal-myosin differ from the other two, by their greater content of sulphur, and also in coagulating, the former at 70° and the latter at 55° C.

* Am. Chem. Journal, **13**, 536.

† Report Conn. Agri. Expt. Station for 1890, pp. 137 and 160; also Am. Chem. Journal, **13**, 389; also Report Conn. Agri. Expt. Station for 1891, p. 135.

‡ Studies from Laboratory of Physiological Chemistry, Yale University, **3**, 133.

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Phaseolin presents many points of difference from the oat-myosin. It is not precipitated from solutions in 10 per cent. sodium chloride by acids, and but slightly by saturation with sodium chloride, and is thrown down, both by dilution and by dialysis, with much greater difficulty than the oat myosin.

SUMMARY OF ANALYSES OF PHASEOLIN FROM THE KIDNEY BEAN.

	1	2	3	4	5	6	7	8	9
Carbon	52.23	52.60	52.60	....	52.54	....	....	52.72	52.35
Hydrogen	6.95	6.69	6.72	....	6.83	....	....	7.24*	6.89
Nitrogen	16.37	16.56	16.17	16.12	16.48	16.23	16.87	16.45	16.52
Sulphur	0.62	0.63	0.63	....	0.58	....	....	0.67	24.24
Oxygen	23.83	23.52	23.88	....	23.57	....	....	22.92	
	100.00	100.00	100.00		100.00			100.00	100.00

	10	11	12	13	14	15	16	17	18†
Carbon	52.74	52.49	....	53.06	52.49	52.47	53.22	....	52.70
Hydrogen	6.84	6.80	....	6.85	6.73	6.90	6.86	....	6.78
Nitrogen	16.65	16.85	16.67	16.68	16.45	16.00*	16.48	16.29	16.71
Sulphur	0.64	23.86	....	23.41	24.13	24.63	0.48	....	0.32
Oxygen	23.13						22.96	....	23.49
	100.00	100.00		100.00	100.00	100.00	100.00		100.00

	19	20	21	22	23	24	Average.	Ritthausen.
Carbon	....	52.20	....	52.55	52.12	52.75	52.58	52.55
Hydrogen	....	6.95	....	6.90	6.70	6.95	6.84	7.09
Nitrogen	16.71	16.26	16.65	16.14	16.21	16.57	16.48	16.18
Sulphur	....	0.51	....	0.58	0.59	0.50	0.56	0.43
Oxygen	....	24.08	....	23.83	24.38	23.23	23.54	23.75
		100.00		100.00	100.00	100.00	100.00	100.00

PREPARATION OF PHASELIN.

Proteid remaining in solution after separation of the Globulin just described.

After precipitating phaseolin by the various methods employed in making the foregoing preparations, the extracts contained proteid matter which could be separated by dialysis in distilled water, by adding acids and by prolonged heating.

These methods of precipitation gave products of nearly uniform composition, except in those cases where the phaseolin had

* Omitted in making average. † Tetrahedral crystals.

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been incompletely separated. Preparations of phaselin were accordingly made as follows:

When a portion of the dialyzed solution from which preparation **1** had been separated, was heated slowly it became turbid at 40°, flocks appearing at 68° in considerable quantity. When filtered, after heating at 72°, a second turbidity was obtained at 83°, and flocks formed at 87° in greater quantity than at 68°. The remaining solution was dialyzed in alcohol until its volume was reduced by one-half. An equal bulk of strong alcohol was then added to the contents of the dialyzer, and the mixture allowed to stand until the precipitate settled. After three days the solution was decanted and the precipitate washed with absolute alcohol and ether and dried over sulphuric acid. The substance, thus dried weighed 11 grams. It was finely ground, thoroughly extracted with distilled water, and this extract filtered from the large insoluble residue. The clear solution was then found to become turbid when heated to 63° and to yield a flocculent coagulum at 76°. The entire solution was therefore heated for several hours in a water bath at 80°, and the coagulum filtered off, washed thoroughly with water, alcohol and ether and dried over sulphuric acid. The 0.9 gram of substance thus obtained, was dried at 110° and analyzed with the following result. Preparation **25.**

PHASELIN, *Preparation* **25.**

		Ash-free.
Carbon	51.67	51.96
Hydrogen	6.67	6.71
Nitrogen	15.55	15.65
Sulphur } Oxygen }	----	25.70
Ash	0.57	----
		100.00

When the filtrate from **25** was again heated to 80°, a further coagulum resulted. The solution was accordingly kept at this temperature as long as any coagulum was produced, filtered, and the coagulum washed with hot water, alcohol and ether, and dried for analysis at 110°. This preparation **26** contained, ash-free, 14.57 per cent. of nitrogen and weighed 0.71 gram.

Two other preparations were made from the filtrate from preparation **3**, in nearly the same way as the two last described, the

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only difference being that the solution was precipitated with alcohol without first concentrating by dialysis in alcohol.

The first coagulum, preparation **27**, obtained by heating at 80° weighed only 0.17 gram, and when dry contained without correction for ash, 14.90 per cent. of nitrogen. The second weighed 1.0 gram and had the following composition:—

PHASELIN, *Preparation* **28**.

		Ash-free.
Carbon	51.19	51.57
Hydrogen	6.87	6.92
Nitrogen	14.36	14.48
Sulphur } Oxygen }	....	27.03
Ash	0.75	....
		100.00

After largely diluting, the filtrate from preparation **16** failed to give any further precipitate on passing carbon dioxide through it for some time. The greater part of this solution was then thrown away, but by chance a little acetic acid was added to the remainder and found to produce a precipitate. This precipitate was filtered off, washed with water, alcohol and ether, and when dried, weighed 0.27 gram and contained without correction for ash, 14.81 per cent. of nitrogen. Preparation **29**.

Another preparation was then made by extracting bean meal with 1 per cent. brine, diluting the extract with a large quantity of water, and filtering off the precipitate. The filtrate was then treated with $\frac{2}{10}$ per cent. hydrochloric acid until a considerable precipitate resulted, which was filtered off and the solution again treated with $\frac{2}{10}$ per cent. hydrochloric acid. This final precipitate was filtered off, washed with alcohol and ether and gave 1.0 gram of preparation **30**, having the following composition:—

PHASELIN, *Preparation* **30**.

		Ash-free.
Carbon	50.18	51.38
Hydrogen	6.53	6.71
Nitrogen	14.44	14.84
Sulphur } Oxygen }	....	26.87
Ash	2.74	....
		100.00

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Again, the filtrate from preparation **10,** was treated with an equal volume of strong alcohol and allowed to stand over night. The next morning, the precipitate which had separated was filtered off and treated with water. This dissolved some of the substance. The solution, filtered clear, when heated, gave a flocculent coagulum at 80°. With acetic, hydrochloric or nitric acid, it gave a precipitate when the reagents were added in sufficient quantity. These precipitates were soluble in sodium chloride solution, and those produced by hydrochloric and nitric acids, were soluble in an excess of the acid, but that given by acetic acid, was not noticeably soluble in an excess. The precipitate obtained with nitric acid, did not dissolve on warming, as is the case with such precipitates yielded by proteoses. The reaction of the extract was slightly acid, but it was not possible to precipitate anything therefrom, by the most careful neutralization. The whole solution was then treated with $\frac{2}{10}$ per cent. hydrochloric acid; the precipitate thus formed had the following composition:—

PHASELIN, *Preparation* **31.**

		Ash-free.
Carbon	49.91	51.98
Hydrogen	6.55	6.82
Nitrogen	13 95	14.53
Sulphur } Oxygen }	----	26.68
Ash	4.00	----
		100.00

The precipitate from which **31** was derived, after this extraction with water, was but slightly soluble in sodium chloride solution, and was therefore treated with $\frac{2}{10}$ per cent. potash-water. The resulting solution was filtered clear, and hydrochloric acid cautiously added, until a precipitate formed which was collected on a filter and treated in the usual manner. When dry, this preparation, **32,** weighed 3.3 grams.

The filtrate from **32** was further treated with $\frac{2}{10}$ per cent. hydrochloric acid, and a second precipitate obtained which weighed 0.6 gram; preparation **33.**

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PHASELIN, *Preparation* 32.

	I.	II.	Average.	Ash-free.
Carbon	51.74	51.74	51.74	52.65
Hydrogen	7.04	7.00	7.02	7.14
Nitrogen	14.89	....	14.89	15.15
Sulphur } Oxygen }	....	....	....	25.06
Ash	1.78	....	1.78	....
				100.00

PHASELIN, *Preparation* 33.

		Ash-free.
Nitrogen	14.24	14.85
Ash	4.12	....

Another preparation was made by extracting 100 grams of bean meal, with 100 cc. of 1 per cent. sodium chloride solution, and washing the insoluble residue with 100 cc. of the same solution, applied in successive portions. The entire extract was then filtered nearly clear, and dialyzed into alcohol. The alcohol of the outer vessel was frequently renewed, and the process was continued until practically all the proteid matter had separated. The precipitate was then filtered off and extracted with 1 per cent. sodium chloride solution. Much of the substance remained undissolved. The solution was filtered clear and dialyzed again, in alcohol of 0.85 sp. gr. which was renewed once during the process. The precipitate resulting was filtered off and washed with dilute alcohol, absolute alcohol and ether and dried at 110°. Its composition was as follows:—

PHASELIN, *Preparation* 34.

		Ash-free.
Carbon	46.49	51.38
Hydrogen	6.25	6.91
Nitrogen	13.27	14.67
Sulphur } Oxygen }	....	27.04
Ash	9.53	....
		100.00

In order to obtain a purer preparation of the proteid by this method, 200 grams of bean meal, first extracted with petroleum-benzine, were treated with 1 liter of 1 per cent. sodium chloride solution and after squeezing out, the residue was mixed with another liter of the same solution and again squeezed. After

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standing over night, the turbid extract was decanted and dialyzed in alcohol for three days, the alcohol being once renewed. This treatment precipitated nearly all the proteids, which were collected on a filter, and after the solution had run off, the precipitate was suspended in ¼ per cent. sodium chloride solution, filtered off and washed with the same solution. The clear filtrate and washings were then dialyzed into alcohol until a considerable precipitate had formed which was filtered off and washed successively with 50 per cent. alcohol, stronger alcohol, absolute alcohol and ether and dried over sulphuric acid. It was then almost wholly soluble in water, but after drying at 110° it became insoluble, and was washed with water, alcohol and ether and again dried, **35.**

PHASELIN, *Preparation* **35.**

	I.	II.	Average.	Ash-free.
Carbon	49.01	....	49.01	51.37
Hydrogen	6.77	....	6.77	7.10
Nitrogen	14.26	13.82	14.04	14.71
Sulphur, Oxygen	....	....	....	26.82
Ash	4.58	....	4.58	....
				100.00

Another trial was made by treating 400 grams of bean meal, previously exhausted by benzine, with 1 per cent. sodium chloride solution, dialyzing the extract for 24 hours, and filtering off the precipitated phaseolin. The clear filtrate after standing over night, deposited a considerable quantity of proteid, but the solution with this deposit was returned to the dialyzer and left for two days longer, when it was filtered, the precipitate washed with water, alcohol and ether, dried over sulphuric acid, and 6 grams of preparation **36,** obtained.

PHASELIN, *Preparation* **36.**

		Ash-free.
Carbon	50.44	51.41
Hydrogen	7.14	7.28
Nitrogen	14.31	14.59
Sulphur	0.46	0.47
Oxygen	....	26.25
Ash	1.94	....
		100.00

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The filtrate from preparation **36** was then dialyzed into distilled water which was renewed every 24 hours for several days. After a week the solution was filtered and the precipitate washed with water, alcohol and ether and dried over sulphuric acid. It weighed 1.60 grams, **37**.

PHASELIN, *Preparation* **37**.

	I.	II.	Average.	Ash-free.
Carbon	51.38	51.22	51.30	52.19
Hydrogen	7.25	6.99	7.12	7.24
Nitrogen	14.52	....	14.52	14.79
Sulphur } Oxygen }	....	....	....	25.78
Ash	1.83	1.61	1.72	....
				100.00

One more preparation, **38**, was made in the same manner as **37**, and had the following composition:—

PHASELIN, *Preparation* **38**.

		Ash-free.
Carbon	50.20	51.27
Hydrogen	7.07	7.22
Nitrogen	14.02	14.32
Sulphur	0.50	0.51
Oxygen	....	26.68
Ash	2.06	....
		100.00

Further dialysis in distilled water, of the filtrate from preparation **37**, gave no more precipitate. The solution was therefore saturated with ammonium sulphate, and the precipitate so produced filtered off and dissolved in distilled water. This solution which now had a volume of about 400cc was dialyzed for some days, first in river water, and afterwards in distilled water, but only a trace of substance separated. This was filtered off, and the perfectly clear solution gave the following reactions:

Saturation with sodium chloride produced no precipitate until acetic acid was added. Acetic acid in the absence of salt gave no precipitate. Nitric acid gave a turbidity when added in considerable quantity, and the addition of some sodium chloride produced no further precipitation. Sulphate of copper gave no pre-

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cipitate. This solution when heated became turbid at 57° and particulate at 63°.

The entire solution was therefore heated to 70° in a water bath which did not exceed this temperature, and after 2 hours, filtered from the separated coagulum. This was then washed with distilled water, alcohol, absolute alcohol and ether, and dried over sulphuric acid. It weighed 0.48 gram. Before drying, this coagulum dissolved readily in $\frac{2}{10}$ per cent. hydrochloric acid, and in dilute potash solution, and gave a violet reaction with sulphate of copper and caustic potash. The filtrate from this coagulum gave a further small coagulum when heated at 70°, for some time longer. This was filtered off, and after treating in the same way as the first coagulum, was added to it. The total amount of coagulum, preparation **39**, amounted to 0.63 gram, and after drying at 110° was found to contain, ash-free, 15.23 per cent. of nitrogen.

The filtrate from **39** was then dialyzed into alcohol, and the solution thereby concentrated. On adding an equal volume of strong alcohol, the proteid was precipitated. This was filtered off, washed with absolute alcohol and ether, and dried over sulphuric acid. It then weighed 0.72 gram which shows that the proteids had been almost wholly precipitated by dialysis and coagulation.

This substance gave a nearly clear solution with distilled water, not made clearer by adding a few drops of sodium chloride solution. With caustic potash and sulphate of copper, a pink color was developed which had a distinct violet tinge, and was by no means so red as that given by pure proteoses and peptones.

The aqueous solution heated to 85° gave a flocculent coagulum which apparently, represented most of the substance. From this, it would appear that true proteoses are present in extremely small amounts.

Dried at 110°, this preparation, **40**, contained, ash-free, 13.60 per cent. of nitrogen. Being thrown down by strong alcohol, it could scarcely be pure, and the nitrogen determination is only of value, as indicating that the coagulum mainly consisted of proteid.

Of these preparations, **25**, **27** and **32**, are unquestionably mixtures of phaseolin and phaselin. Excluding these three and also **39** and **40**, evidently impure, the remaining agree fairly well, as is shown by the following table:

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SUMMARY OF ANALYSES OF PHASELIN FROM THE KIDNEY BEAN.

	26	28	29	30	31	33
Carbon	....	51.57	....	51.59	51.98	....
Hydrogen	....	6.92	....	6.71	6.82	....
Nitrogen	14.57	14.48	14.81	14.84	14.53	14.85
Sulphur, Oxygen	....	27.03	....	26.87	26.68	....
	------	100.00	------	100.00	100.00	------

	34	35	36	37	38	Average
Carbon	51.38	51.37	51.41	52.19	51.27	51.60
Hydrogen	6.91	7.10	7.28	7.24	7.22	7.02
Nitrogen	14.67	14.71	14.59	14.79	14.32	14.65
Sulphur	27.04	26.82	0.47	25.78	0.51	0.49
Oxygen			26.25		26.68	26.24
	100.00	100.00	100.00	100.00	100.00	100.00

It is probable that these analyses pretty closely represent the true composition of this proteid, the various preparations having been made under such diverse conditions as to exclude the possibility of their being mixtures of the phaselin with non-proteid substances.

Preparations **26** and **28** were precipitated by heat, **29** and **30** by acid. Preparations **31, 34** and **35** were thrown down by alcohol, extracted by water from the precipitate so produced, and separated from the solution—**31** by acid, and **34** and **35** by dialysis in alcohol. Finally, **36, 37** and **38** were obtained by fractional dialysis in water.

There is some difficulty in deciding to what class of proteids phaselin should be assigned. It most nearly agrees with the globulins, being precipitated by dialysis after nearly all the salts are removed, and thereby largely converted into an insoluble form. Complete precipitation is not accomplished, even by prolonged dialysis in distilled water, and it may be questioned whether the precipitation that occurs on dialysis in water, is not the result of transformation into "albuminate."

Nitric acid in sufficient quantity gives a precipitate which, on warming, does not dissolve in the manner characterizing proteoses. Saturation with sodium chloride, gives only a slight precipitate, but further addition of acetic acid, occasions an abundant precipitate. With copper sulphate and caustic potash, a violet color is produced.

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The coagulum produced by heat, dissolves in $\frac{1}{10}$ per cent. hydrochloric acid when heated to 80°. The temperature at which coagulation commences, varies with the amount of salts present, a turbidity usually appearing between 40° and 50° in solutions which have been dialyzed until the greater part of the phaseolin has been separated. The 10 per cent. sodium chloride extract of the bean meal, became turbid at 52°–55°, flocks forming at 68°–70°. The aqueous extract of the meal, heated to 60° gave a turbidity but slightly increased by boiling. When 10 per cent. of sodium chloride was added to the aqueous extract, turbidity occurred at 37° and flocks formed at 52°. The coagulation of this proteid by heat, proceeds very slowly and is completed only by very prolonged heating, for days even, at a temperature considerably higher than that at which flocks first appear.

Amount of Proteids in the Kidney Bean.

The quantities of these two proteids occurring in the kidney bean cannot be accurately determined, owing to the difficulties encountered in separating them. An approximate estimate is as follows:

1. A sample of freshly ground air-dry bean meal yielded by combustion, 3.785 per cent. of nitrogen. Considering all the nitrogen to exist as proteids containing 16 per cent. of this element, the proportion of proteids in the bean meal would be ($3.785 \times 6.25 =$) 23.65 per cent.

2. Twenty grams of bean meal were treated repeatedly with 10 per cent. sodium chloride solution, until no more proteids could be extracted. The residue, after washing with water, alcohol and ether, weighed air-dry 11.41 grams and contained 1.877 per cent. or 0.214 grams of nitrogen, equivalent to 1.338 grams of salt-insoluble proteid, which amounts to 6.69 per cent. of the meal. The salt-soluble proteids were accordingly ($23.65 - 6.69 = 16.96$) 17 per cent. of the meal.

3. In making preparations **4**, **5**, **6** and **7**, p. 190, the phaseolin obtained from the salt-extract amounted to 14.77 per cent. This when weighed was not altogether pure or dry, but on the other hand, a part of this proteid existing in the salt extract, was not recovered, so that it may be fairly assumed that the meal contains about 15 per cent. of salt-soluble phaseolin. This deducted from the 17 per cent. of total salt-soluble proteids, leaves 2 per

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cent. for phaselin, reckoned water-free, other proteids being present in very minute quantity.

4. The preparations **36, 37, 39** and **40,** pp. 204–6 were obtained from one and the same portion, 400 grams, of bean meal, after phaseolin had been as completely removed as practicable. These preparations after drying over sulphuric acid, weighed respectively 6.00, 1.60, 0.63 and 0.72 grams, their total weight being 8.95 grams, equal to 2.24 per cent. of the meal. Their average nitrogen content was 14.54 per cent. very nearly that of phaselin. Making liberal allowance for impurities and incomplete drying, they represent about 2 per cent. of phaselin.

5. Twenty grams of bean meal were extracted as completely as possible with $\frac{1}{10}$ per cent. potash-water. The washed and air-dry residue weighed 11.27 grams, and contained 0.91 per cent. or 0.1026 grams of nitrogen, equal to 0.611 grams of (water-free) proteid, insoluble in alkali, or to 3.06 per cent. of the meal. The alkali-soluble proteid amounted therefore to (23.65 − 3.06 = 20.59) 20.6 per cent. of the meal.

6. On pages 193–4 is recorded that the proteid insoluble in salt solution, but dissolved by $\frac{1}{10}$ per cent. potash, **15,** contained 16 per cent. of nitrogen and accordingly had nearly the composition of phaseolin. It is, therefore, probable that the proteid undissolved by salt-solution, is phaseolin. On this assumption, the kidney bean examined, contains about 21.5 per cent. of phaseolin, and about 2 per cent. of phaselin.

7. The foregoing data are summarized as follows:—The "white medium field bean" contains approximately.

Phaselin, salt-soluble	2	per cent.
Phaseolin, salt-soluble	15	"
Phaseolin? salt-insoluble, alkali-soluble	3.5	"
Phaseolin? insoluble in salt and in $\frac{1}{10}$ per cent. alkali	3	"
Total proteids	23.5	"

Schulze, Steiger and Maxwell have stated * that 10 per cent. of the nitrogen of the seeds of the horse bean (*Vicia faba*) the vetch and the pea, exists in non-proteid form. Should such prove to be the case with the kidney bean, then its total proteids would be about 21 per cent. instead of 23.5 per cent.

* Versuchs Stationen xxxix, 306.

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Conclusion.

The kidney bean contains two globulins characterized by great solubility in very dilute saline solutions, and by yielding precipitates with acids which are soluble in sodium chloride solutions. One of these globulins, *phaseolin*, probably forms about 20 per cent. of the seed, and has the following composition, which is the average of analyses of 24 different preparations:—

Phaseolin.

Carbon	52.58
Hydrogen	6.84
Nitrogen	16.47
Sulphur	0.56
Oxygen	23.55
	100.00

This is the proteid described by Ritthausen in 1884, to which he assigned very nearly the same composition as that above given.

The other proteid, *phaselin*, is much more soluble, remaining in solution after the phaseolin has separated. It is slowly coagulated by heat at temperatures varying with the amount of salts present and the rapidity of heating. It is precipitated by acids, on prolonged dialysis yields insoluble or albuminate modifications, and has more nearly the properties of a globulin than of any other recognized class of proteids. It has an unusually low nitrogen and high oxygen content as shown by the subjoined average of the analyses of 11 different preparations:

Phaselin.

Carbon	51.60
Hydrogen	7.02
Nitrogen	14.65
Sulphur	0.49
Oxygen	26.24
	100.00

In addition to these two globulins, the extracts were found to contain an extremely small amount of *proteose*.

May, 1893.

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THE PROTEIDS OF COTTONSEED.

By Thomas B. Osborne and Clark G. Voorhees.

The only reference to the proteids of cottonseed which we can find was made by Ritthausen in 1881 (Jour. f. prakt. Chem., xxiii, 485), who stated that he had been unable to obtain crystals of proteid matter from this seed and also that he would soon publish his completed investigations of the proteid bodies of this as well as of several other seeds which he named. Papers on the proteids of the other seeds mentioned by him were subsequently published, but we have not found anything relating to those of cottonseed. Since so long a time has elapsed, we feel warranted in assuming that Ritthausen has abandoned his intention of reporting the results of his investigation. The importance which cottonseed meal has assumed as a cattle-food of late years, makes it desirable to understand its chemical composition, especially as regards the nitrogen compounds which it contains so abundantly. Our results are not as satisfactory as we hoped for when we undertook this work but we have decided to publish them as they stand and shall endeavor to make them more complete in the future. The difficulties encountered are due to the presence of substances which render filtration of the extracts extremely slow and to the large amount of coloring matters taken up from the seed together with the proteids, which could be separated only with difficulty and large loss of substance. The material used in our investigation consisted partly of seed from which the cotton had been removed, but which otherwise was in the condition in which it was harvested. We separated the kernels from these seeds by chopping them in a wooden bowl and sifting out the larger fragments of husk. We thus succeeded in obtaining meal nearly free from hulls. This meal was bruised in a mortar and freed from most of the oil by extraction with benzine and from benzine by drying in the air at the temperature of the room. Samples of commercial cottonseed meal from which the oil had been expressed by the usual process were also used and gave the same result when extracted, and therefore in the following account of our experiments, no special mention is made of the origin of the meal employed.

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a. Extraction with Water.

100 grams of cottonseed meal were extracted with 3 liters of distilled water and the filtered extract saturated with ammonium sulphate. The small precipitate so produced was filtered off, dissolved in water, the solution filtered clear and placed in a dialyzer. After remaining a week in running water no precipitation occurred, showing the absence of any notable quantity of globulin soluble in the dilute saline solution produced by the salts of the seed with the water used in the extraction. The dialyzed solution gave no immediate coagulum on boiling, proving the absence of albumins. The solution was then evaporated over a lamp and, after boiling some time, a light, bulky coagulum gradually separated. When the solution became quite concentrated, the coagulum was filtered off, washed with water, alcohol and ether, dried over sulphuric acid and found to weigh 0.25 gram. The filtrate from this coagulum was evaporated to small volume on a water-bath and precipitated by pouring into absolute alcohol. The precipitated proteid was then washed with absolute alcohol and ether and weighed, when dry, 0.40 gram. Accordingly, 0.65 per cent. of the oil-free meal, consisted of water-soluble proteose-like matter. The amount of this substance was so small, and the difficulty of preparing it in a state of purity so considerable, that it was not further examined. Other experiments, both with water and saline solution, fully confirmed the results here described and left no doubt that the amount of water-soluble proteid is very small.

b. Extraction with Sodium Chloride Solution.

When treated with 10 to 20 per cent. sodium chloride solution, the cottonseed meal yields a slightly acid extract of a yellowish-pink color which is viscid, and difficult to filter. When heated slowly, this extract becomes turbid at 44°, flocks, in small amount, separating at 64°. Filtered after heating to 70°, the solution becomes turbid when heated again to 70° and flocks in larger amount separate at 93°.

Saturation with sodium chloride gives a slight precipitate. Dilution of the extract with water yields an abundant precipitate which is redissolved on warming and again separates in the form of spheroids when cooled.

50 grams of oil-free meal were extracted with 10 per cent. sodium chloride solution, and the meal washed with the same

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solution as long as any proteid could be extracted. The extract and washings were saturated with ammonium sulphate, the precipitate produced filtered off, dissolved in dilute sodium chloride brine, filtered and dialyzed for four days. The solution was then removed from the dialyzer and the precipitated globulin filtered off, washed with water, alcohol and ether, and dried over sulphuric acid. There was thus obtained 7 grams or 14 per cent. of light yellowish proteid which when dried at 110°, had the composition given below, Preparation **1.**

A second preparation was made by treating 100 grams of meal with 3 liters of 20 per cent., sodium chloride solution for 48 hours and, after filtering, saturating the extract with ammonium sulphate. The meal-residue was again treated with 20 per cent. sodium chloride brine and after filtering the extract, it was saturated with ammonium sulphate and added to the first.

The ammonium sulphate precipitate was filtered off and dissolved in 10 per cent. sodium chloride solution, yielding a deep brown liquid. This was filtered clear and dialyzed till free from chlorides when the precipitate was filtered off and treated in the usual way. There resulted 15.83 grams of globulin of a slightly yellowish color which had the composition stated below, Preparation **2.**

A third preparation was obtained by extracting 100 grams of meal with water and then treating the residue with 20 per cent. sodium chloride solution.

The salt-extract was filtered, saturated with ammonium sulphate and otherwise treated in the manner already described in making preparations **1** and **2.** Only 8.39 grams of globulin were recovered, indicating a conversion into the insoluble modification, through contact with water.

The composition of this preparation **3,** is shown by the following figures.

COTTON SEED GLOBULIN.

	1				2				3	
	I.	II.	Av.	Ash-free.	I.	II.	Av.	Ash-free.		Ash-free.
Carbon	51.85	....	51.85	51.91	51.75	....	51.75	51.86	51.66	51.77
Hydrogen	6.78	....	6.78	6.79	6.87	....	6.87	6.88	6.73	6.74
Nitrogen	18.02	18.12	18.07	18.09	17.90	18.15	18.03	18.07	17.93	17.97
Sulphur	0.68	....	0.68	0.68	0.67	....	0.67	0.67	0.71	0.71
Oxygen	....	....	....	22.53	....	....	....	22 52	....	22 81
Ash	0.11	....	0.11	....	0.21	....	0.21	....	0.22	....
				100.00				100.00		100.00

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The properties and composition of this substance are so similar to those of the vegetable vitellin found in the seeds of flax, hemp, wheat and other seeds, it seemed probable that the three preparations just described were not entirely pure and that if freed from all foreign matters they would agree more closely with the globulin of the seeds just named. Three preparations were accordingly made, substantially in the manner already described and, after drying over sulphuric acid, they were redissolved in 10 per cent. sodium chloride brine and the resulting clear solutions were dialyzed. The globulin thus reprecipitated was filtered off, thoroughly washed with water, alcohol and ether and when dried at 110° analyzed with the following results:

COTTON SEED GLOBULIN. EDESTIN.

	4		5		6			
		Ash-free.		Ash-free.	I.	II.	Av.	Ash-free.
Carbon	51.59	51.75	51.56	51.93	51.68	51.58	51.63	52.05
Hydrogen	6.68	6.70	6.92	6.97	7.11	6.92	6.97	7.02
Nitrogen	18.72	18.78	18.40	18.52	18.66	18.40	18.53	18.68
Sulphur	0.75	0.75	0.50	0.51	0.66	....	0.66	0.66
Oxygen	....	22.02	....	22.07	....	....	....	21.59
Ash	0.33	....	0.74	....	0.82	....	0.82	....
		100.00		100.00				100.00

We next attempted to detect the presence of other globulins in the sodium chloride extract. One kilogram of cottonseed meal was extracted with 10 per cent. sodium chloride solution and as the extract after straining through cloth was quite concentrated and could not be filtered, it was shaken with ether so as to remove oil and other substances soluble in that liquid. On standing, a part of the aqueous solution separated, leaving a supernatant layer consisting of an emulsion which long standing failed to resolve. Addition of alcohol, instead of breaking up the emulsion, transformed it into a jelly-like mass of considerable solidity. The unemulsified part of the extract, after standing some time, was decanted and dialyzed free from chlorides. The dialyzed solution was allowed to stand until the globulin had deposited when the supernatant liquid was decanted. The separated globulin was treated with 10 per cent. sodium chloride brine and the solution filtered very nearly clear. This solution was then dialyzed for 18 hours, during which time a large precipitate formed which was filtered off, washed with water, alcohol and ether, and when dried over sulphuric acid weighed 23.63 grams, Preparation 7. The filtrate was found to be practically free from proteids. The

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solution decanted from the first precipitation of the globulin contained a large amount of very finely divided substance that would not settle. A little sodium chloride was therefore added which dissolved the suspended globulin. The solution was next saturated with ammonium sulphate and the large precipitate filtered off, dissolved in water, the solution filtered perfectly clear, and dialyzed for several days. It was then removed from the dialyzer and allowed to stand until the suspended globulin had mostly settled out. The milky solution was then decanted from the sediment and the latter washed with water, alcohol and ether. After drying over sulphuric acid it weighed 8.58 grams. Preparation **8.** The solution decanted from **8,** after repeated filtration was obtained clear and was again dialyzed. After several days a very small precipitate formed which when subjected to the usual treatment weighed but 0.82 grams. This was much colored and evidently impure. The solution filtered from this precipitate was saturated with ammonium sulphate and yielded only a very small precipitate which appeared to consist mostly of proteose. The emulsion obtained by shaking the original extract with ether, after standing some days gave no evidence of resolution. The jelly-like mass was therefore broken up and thrown on a filter. A clear quick-running filtrate was obtained which was dialyzed for 5 days and deposited a globulin, that, after the usual treatment, weighed 8.43 grams. Preparation **9.** All these preparations were analyzed with the following results:

COTTON SEED GLOBULIN. EDESTIN.

	7				8		9	
	I.	II.	Av.	Ash-free.		Ash-free.		Ash-free.
Carbon	51.59	51.45	51.52	51.75	51.38	51.44	51.10	51.33
Hydrogen	7.04	6.70	6.87	6.90	6.70	6.70	6.88	6.91
Nitrogen	18.76	18.71	18.74	18.82	18.49	18.51	18.47	18.55
Sulphur	0.61	----	0.61	0.61	----	23.05	0.60	0.60
Oxygen	----	----	----	21.92	----		----	22.61
Ash	0.46	----	0.46	----	0.12	----	0.46	----
				100.00		100.00		100.00

The above analyses show that the first three preparations were not quite pure and the extract last made affords satisfactory evidence that no other salt-soluble globulin exists in the cottonseed in noteworthy amount. In the following table the analyses of the purer preparations may be compared together.

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SUMMARY OF ANALYSES OF COTTONSEED GLOBULIN. EDESTIN.

	4	5	6	7	8	9	Average.
Carbon	51.75	51.93	52.05	51.75	51.44	51.33	51.71
Hydrogen ..	6.70	6.97	7.02	6.90	6.70	6.91	6.86
Nitrogen ...	18.78	18.52	18.68	18.82	18.51	18.55	18.64
Sulphur ...	0.75	0.50	0.66	0.61	23.05	0.60	0.62
Oxygen	22.02	22.08	21.59	21.92		22.61	22.17
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The table subjoined shows that this substance agrees in composition with the vitellin which exists in the seeds of wheat, maize, hemp, castor bean, squash and flax. As the properties of the preparations obtained from all these sources are substantially alike, there can be little doubt that one and the same proteid exists in them all. For this body we adopt the name *Edestin*, from the Greek *εδεστὸς*, signifying edible, in view of its occurrence in so many important food-stuffs.

COMPOSITION OF EDESTIN FROM VARIOUS SEEDS

	Wheat kernel.	Maize kernel.	Hemp seed.	Castor bean.	Squash seed.	Flax seed.	Cotton seed.
Carbon	51.03	51.71	51.28	51.31	51.66	51.48	51.71
Hydrogen ..	6.85	6.85	6.84	6.97	6.89	6.94	6.86
Nitrogen ...	18.39	18.12	18.84	18.75	18.51	18.60	18.64
Sulphur	0.69	0.86	0.87	0.76	0.88	0.81	0.62
Oxygen	23.04	22.46	22.17	22.21	22.06	22.17	22.17
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The considerable differences in carbon and nitrogen in the above analyses amounting in the extreme cases to 0.7 per cent. are, in general, not greater than the discrepancies between analyses of preparations from the same seed. In the seeds of wheat and maize, other water- and salt-soluble proteids occur in considerable quantities and it is probable that the crystallized preparations obtained from hemp, castor bean, squash and flax more truly represent the composition of edestin than the amorphous or spheroidal substance yielded by the cereal seeds.

The slight differences in the deportment of solutions of these preparations of edestin may be reasonably attributed to admixtures of traces of other proteids.*

c. *Extraction with Potash-water.*

After extraction with water and sodium chloride solution a considerable amount of proteid was always found in the residual

* See paper on Crystallized Vegetable Proteids, by T. B. Osborne, Am. Chem. Journal, xiv, p. 688.

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meal which could be partly removed by $\frac{2}{10}$ per cent. potash solution. All attempts to obtain the proteid thus extracted in a pure state, have hitherto entirely failed. Much coloring matter passes into the alkaline solutions, and when the proteid is precipitated goes down with it and cannot be removed by any process we have hitherto applied.

When freshly prepared, the alkaline extracts, as well as the meal moistened with the alkali, are of a bright reddish yellow color, but on exposure to the air they rapidly darken and finally become greenish-black. So much gummy matter is also extracted by alkaline solutions that it is almost impossible to filter them clear. As a result no preparations were obtained, the analysis of which could shed any light on the composition of the proteid which they represented. The residue of meal after treatment with potash still contains a notable quantity of nitrogen.

d. Amounts of the different forms of proteids in Cottonseed.

As already shown, the proteid matter of cottonseed soluble in water, consists almost wholly of proteose. Making full allowance for incomplete extraction and loss, this does not exceed 0.75 per cent. of the oil-free meal. The highest yield of globulin recovered in the preceding extractions was 15.83 per cent. of the oil-free meal, and contained 42.3 per cent. of the total nitrogen. After repeated extraction with potash water, the residue contained, in the case where extraction was most complete, 11.4 per cent. of the total nitrogen, showing that 88.6 per cent. of the total nitrogen had been dissolved. The difference between the percentage of nitrogen removed by sodium chloride solutions and that extracted by weak potash, represents the proteid dissolved by potash-water which is not soluble in saline solutions, and which corresponds to 46.3 per cent. of the total nitrogen, assuming all this nitrogen to be present in proteid form.

These data may be tabulated as follows:—

	Per cent. of— Air-dry and oil-free bean meal.	Total nitrogen.
Proteose	0.75	2.0
Salt-soluble proteid. Edestin	15.83	42.3
Alkali-soluble and salt-insoluble proteid	....	44.3
Proteid insoluble both in salt and alkali	....	11.4
		100.0

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METHODS TO DETERMINE THE AVAILABILITY OF ORGANIC NITROGEN IN FERTILIZERS.

I. PEPTIC DIGESTION. RESULTS OF OUR FORMER EXPERIMENTS.

In the Report of this Station for 1885, pp. 115–131, is an account of experiments on the solubility in pepsin-hydrochloric acid of such organic nitrogenous matters as are commonly used in mixed fertilizers and also of certain materials which, though known to be very inferior as sources of nitrogen to crops, are yet put upon the market for use as fertilizers.

The conclusions from our experiments and those of Drs. Shepard and Chazal, our predecessors in this work, were given substantially as follows:

"1. The nitrogen of dried blood (red and black, 4 samples), cotton seed (4 samples), castor pomace and maize refuse (each 1 sample) was in every case soluble in pepsin-hydrochloric acid, by 24 hours digestion, to the extent of 75 per cent. or more.

2. The nitrogen of fish (10 samples), dried animal matter (tankage, horse meat, etc., 3 samples), and of bone (20 samples), was in every case soluble to the extent of over 52 per cent.

3. The nitrogen of leather, steamed or extracted by benzine, was in no case soluble to the extent of over 36 per cent. That of horn shavings, bone dust, ground horn and hoof, cave guano, felt waste and wool waste was considerably less soluble than the nitrogen of leather.

4. This method divides the organic nitrogenous matters used in fertilizers into two classes. In one more than one-half of the nitrogen is soluble, in the other scarcely more than one-third is soluble. To the first class belong all the materials whose nitrogen is known to be readily 'available' in the usual sense. Of the second class, the most soluble are leathers variously manipulated, which are comparatively valueless as ingredients of commercial fertilizers. To some extent this method is therefore a measure of the agricultural value of nitrogen. How far it is a measure must be determined by vegetation-experiments under accurately controlled conditions, in which nitrogen is supplied in the same materials which have been tested by digestion-experiments.

In the mean time the method has decided value because in many cases it will distinguish in mixed fertilizers between such

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forms of nitrogen as the general sense of practical farmers accepts as available and such as the same tribunal condemns as inert."

II. PEPTIC DIGESTION. TRIALS MADE IN 1893.

a. The Method.

Preliminary to the tests of mixed fertilizers in 1893 and in order to still further prove the method and to compare the efficiency of the pepsin now obtainable with that of the pepsin used in the experiments of 1885, certain raw materials containing nitrogen were first examined.

With raw materials the method pursued was as follows:

One gram of the substance, pulverized to pass circular holes $\frac{1}{50}$ in. in diameter, was brought into a 150 c. c. flask, with 100 c. c. of pepsin-hydrochloric acid solution.*

This solution was prepared by mixing 5 grams of Parke and Davis' pulverized pepsin (guaranteed to dissolve 2,000 times its weight of coagulated white of egg) in 1,000 c. c. of hydrochloric acid diluted to a strength of two-tenths per cent.

The flasks containing the weighed substance together with pepsin solution were kept for 24 hours loosely corked in a water-bath having a constant temperature of 40° C.

At the end of the 2d, 5th, 8th and 11th hours, 2 c. c. of a ten per cent. hydrochloric acid solution were added.

After twenty-four hours' digestion the contents of the flasks were filtered and nitrogen was determined, by the Kjeldahl method, in the washed and dried residues.

b. Digestion of Raw Materials mostly of Known Good Quality.

Ground Bone.—The nitrogen of eight samples of fine, clear, hard bone, presumably the ground sawings and shavings from the manufacture of bone and "ivory" goods, had an average solubility of 96.5 per cent. The highest observed solubility was 99.5, the lowest 94.3.

The average nitrogen-solubility of the other 21 samples of bone, which included raw and steamed bone as well as bone from glue factories, was 88.9 per cent. The highest solubility was 97.1, the

* This digestive solution will be commonly referred to as pepsin simply.

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lowest 69.2. A single exception to the above statement was a sample sent to the Station as "Preston's Ground Bone," No. **3750.** It was a mixed fertilizer containing 3.52 per cent. of nitrogen, 7.33 per cent. of phosphoric acid and 3.50 per cent. of potash. The nitrogen-solubility of this sample was only 59.7 per cent. The sample gave reactions which are characteristic of leather.

Dried Blood.—A sample of "English Dried Blood" had a nitrogen-solubility of 94.2 per cent., one of black blood of 83.8 per cent.

Tankage.—In three samples the average amount of nitrogen dissolved was 73.6 per cent.; the highest 82.1, the lowest 66.2 per cent.

Dry Ground Fish.—The nitrogen of two samples was soluble to the extent of 75.6 and 75.8 per cent.

Ammonite.—The nitrogen dissolved from a single sample was 78.2 per cent.

Cotton Seed Meal.—The average nitrogen-solubility of five samples of decorticated upland meal was 86.4 per cent. The lowest solubility was 81.4, the highest 91.6 per cent.

The nitrogen-solubility of three samples of undecorticated "Sea Island" meal was considerably less. The average solubility was 77.7; highest 82.6, lowest 74.3 per cent.

Castor Pomace.—The average nitrogen-solubility of four samples was 88.5 per cent.; highest 90.0, lowest 85.7.

Linseed Meal.—The solubility of the nitrogen of one sample tested was 83.8 per cent. The nitrogen of a mixed fertilizer, **3853,** in which linseed meal is used as the source of nitrogen, had a solubility in the pepsin of 87.7 per cent.

Pea Meal.—The nitrogen of a single sample was soluble in pepsin solution to the extent of 92.2 per cent.

c. Digestion of Cheap "Ammoniates," used as Adulterants.

The following are results of tests made on samples of certain suspicious articles which were offered to "the trade" during the season of 1893.

We are credibly informed that in many places where tanning or boot and shoe making are large industries, the hide and leather scraps are bought up and "manufactured" for the fertilizer trade.

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There are at least two kinds of material put on the market from these sources. One consists of tanners' refuse, from which the grease is first extracted and which is then pressed in bags. This has a snuff-brown color. Another consists of leather chips which, after grease has been removed, are made brittle by acid or heat. This stuff, when ground, is not unlike dried blood in appearance, but when unmixed has the smell of leather and where benzine has been used to extract grease, the odor of this solvent becomes evident on pulverizing the leather. Thousands of tons of this material are manufactured yearly.

Various forms of wool waste, as well as horn and hoof meal are also known to be in the market and are often sold under the name of "animal matter" or "tankage."

The articles examined are briefly described as follows:

A. "Animal matter, running about 10 per cent. ammonia." Price $2.50 per unit of ammonia, March 25, 1893.

B. "Tankage." Price very low. Its appearance is much like that of dried blood. It smells like leather and when pulverized emits a faint odor of benzine.

C. "Sample of 50 tons fine ground Animal Matter, testing about 10 per cent. ammonia. $2.40 per unit f. o. b."

D. "Tankage made in Philadelphia to amount of 300 tons at least, testing about 10 per cent. ammonia. Price $2.40 per unit."

E. "Fine Ground Animal Matter testing about 10 per cent. ammonia. 60–80 tons at $2.50 per unit ex. steamer N. Y."

F. "Tankage." $2.50 per unit ex. ship.

G. "Ammonite, Type A. Testing about 17 to 18 per cent. ammonia. Probably could secure 25 tons a month at $2.60 ex. ship."

Samples A, B, D, E, are unquestionably in great part leather.

These "goods" are well adapted to use in compounding fertilizers. They "analyze well" and, at the prices quoted, supply nitrogen for from 14.6 to 15.8 cents per pound wholesale, which, mixed with the materials required for the "Superphosphates" sold in Connecticut, would be "valued" by this Station at 17½ cents and would cost the purchasers on the average 24½ cents per pound. See pages 37–41, where the average cost of nitrogenous superphosphates is shown to exceed the average valuation by 40½ per cent.

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NITROGEN OF INFERIOR "AMMONIATES" AND ITS SOLUBILITY IN PEPSIN.

	TOTAL NITROGEN in per cent. of the substance.	PEPSIN-SOLUBLE NITROGEN in per cent. of the substance.	PEPSIN-SOLUBLE NITROGEN in per cent. of total Nitrogen.
A	7.70	2.68	34.8
B	7.27	2.58	35.5
C	7.78	2.51	32.2
D	8.07	4.23	52.4
E	8.07	3.18	39.4
F	7.64	2.88	37.7
G	13.72	5.73	41.8

A comparison of the results of these tests made in 1893 with those made on similar materials in 1885 shows substantial agreement and proves that the pepsin solutions used in the two series of trials were alike in their solvent action.

d. DIGESTION OF MIXED FERTILIZERS.

Every mixed fertilizer analyzed at this Station during the season of 1893 was tested with pepsin-hydrochloric acid to determine the solubility of its organic nitrogen in that reagent. The object of this treatment was to learn if there are fertilizers of this class in the Connecticut market whose organic nitrogen is so far insoluble as to make their further examination desirable.

One gram of the mixed fertilizer was washed on a filter with about 250 c. c. of cold water to remove soluble salts and the residue was treated with pepsin solution as already described.

It is unnecessary to give in detail the nitrogen-solubility of each of the 125 brands of mixed fertilizers examined in this manner. The general results are as follows:

SOLUBILITY IN PEPSIN OF THE ORGANIC NITROGEN OF 125 MIXED FERTILIZERS.

Over 90	p. c. of	Organic	Nitrogen of	3	Brands is soluble in	Pepsin.	
Between 80 and 90	"	"	"	22	"	"	"
" 70 " 80	"	"	"	62	"	"	"
" 60 " 70	"	"	"	18	"	"	"
" 50 " 60	"	"	"	12	"	"	"
" 40 " 50	"	"	"	6	"	"	"
Under 40	"	"	"	2	"	"	"

The organic nitrogen of the three brands that head the above table is that of hard, clear bone.

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In so far as this method, in its present development, can indicate, a fertilizer, 60 per cent. of whose organic nitrogen is pepsin-soluble, may be regarded as satisfactory.

There is indeed no reason to condemn a fertilizer whose nitrogen-solubility is but 50 per cent., without further evidence. But when the nitrogen-solubility is under 50 per cent. the fact in itself is suspicious.

Of the 125 brands of mixed fertilizers examined, this method accordingly finds that 105 were above suspicion, 12 were near the danger line, and 8 were to be suspected of containing some comparatively worthless form of organic nitrogen. The method cannot at present do more than create a strong presumption for or against the quality of the goods.

III. PUTREFACTIVE DECAY, EXPERIMENTS OF 1893.

a. The Method.

It was sought to determine, in a considerable number of fertilizers, the quantity of nitrogen which is made soluble by putrefactive processes.

The tests were made as follows:

Bone, fish, dried blood and all other materials which were free from nitrates and salts of potash and ammonia, were brought directly into flasks for putrefaction.

Of mixed and acidulated fertilizers, duplicate portions of two grams each, were washed on filters with about 250 c. c. of cold water, to remove soluble matters.

The washed residues, or two grams of raw material containing no soluble salts, were brought into flasks with 350 c. c. of distilled water and 10 c. c. of a solution in which raw beef and horse manure had been allowed to putrefy for some days.

The flasks stood in an outbuilding exposed to summer temperature, in a dim light and protected from insects. From time to time their contents were shaken up and the evaporated water was replaced.

After forty-eight days the solutions were all filtered, nitrogen was determined in some of the residues, the others were washed back into the flasks with 350 c. c. of tolerably pure lake-water from the service pipes. To each was added 10 c. c. of putrid filtrate from the foregoing filtrations.

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The flasks were left in the outbuilding till late in September when they were brought into the laboratory, where they remained at a nearly uniform temperature of about 70° F. After 79 days from the beginning of the test, nitrogen was determined in certain of the samples; after 145 days certain others were examined and the test was concluded after 215 days. The results are as follows:

b. Putrefaction of Raw Materials.

It appears that in many cases there was considerable dissolving of nitrogen after the lapse of 145 days, in some instances as much as 9 per cent. became soluble during the last two months.

In a considerable number of cases, the quantity of nitrogen dissolved by putrefaction, during 7 months, does not agree with or bear any very definite relation to the quantity dissolved by pepsin solution.

The most striking discrepancies are observed with ground bone. All the samples were pulverized to pass holes of $\frac{1}{16}$ inch, but while in four cases the correspondence of percentages by the two methods is fair, in five other cases there is no agreement whatever.

The widest discrepancies occurred with the samples of hard raw bone, which it is evident are likely to be less finely ground than the steamed or soft bone and, if pulverized to the same degree, are less easily penetrated and dissolved by the putrefactive agencies.

Extremely fine pulverization might have increased the nitrogen-solubility in putrefaction very considerably and thus have made a more satisfactory agreement with the results of the peptic digestion.

The nitrogen of cottonseed meal, linseed meal and castor pomace was quite readily dissolved during putrefaction though not to the same extent as with pepsin solution.

It is noticeable that the nitrogen of the two samples of undecorticated meal is much less soluble than that of clear decorticated meal under putrefaction as well as in pepsin solution.

In the single samples of fish, blood and ammonite there was substantial agreement between the results of the two methods.

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SOLUBILITY OF ORGANIC NITROGEN IN VARIOUS RAW MATERIALS.

	Total Organic Nitrogen (in per ct. of substance.)	Organic Nitrogen Dissolved (in per cent. of total Nitrogen)				
		by Peptic Digestion in 24 hrs.	by Putrefaction			
			in 48,	79,	145,	215 days.
Fish	8.06	75.6	---	78.5	---	---
Blood	11.88	94 2	78.2	72.4	---	---
Ammonite	13.51	78.2	---	---	88.0	87.6
Linseed Meal	5.98	83.8	74.6	81.6	---	---
Cotton Seed Meal	8.08	91.6	73.0	82.1	---	---
" "	6.64	82.0	---	---	75.9	72.4
"undecorticated	3.97	74.3	41.8	40.8	---	---
" "	3.71	76.1	---	---	46.9	45.8
Castor Pomace	5.39	90.0	---	---	72.2	80.3
" "	4.39	85.7	---	---	66.1	---
" "	4.64	88.4	62.5	74.1	---	---
"Bone"	4.07	95.9	11.8	19.1	---	---
"	4.10	94.4	---	---	47.3	55.1
"	3.91	91.6	35.0	42.2	---	---
"	4.24	97.1	37.7	43.1	---	---
"	4.18	94.5	---	---	29.9	34.2
"	3.26	83.1	---	---	78.9	---
"	1.52	92.1	---	---	71.1	75.7
"	1.76	80.7	66.5	80.0	---	---
"	3.94	81.5	---	---	80.7	85.8
"	2.76	85.5	---	---	77.2	83.7

Lastly, the two methods of determining nitrogen-solubility fairly agree in the case of three nitrogenous materials, known to be of inferior quality, as appears below.

	Nitrogen-Solubility in Pepsin Solution.	under Putrefaction.
F. "Tankage"	37.7 per cent.	35.2–37.0
C. "Ground Animal Matter"	32.2 "	41.5–42.7
G. "Ammonite A"	41.8 "	37.1–47.6

c. PUTREFACTION OF MIXED FERTILIZERS.

The next table presents the general results of the tests of mixed fertilizers by the putrefactive method and a comparison with the peptic digestion of the same articles.

There is seen to be a practical conformity between the indications of the two methods, though in many cases the agreement is not close.

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ORGANIC NITROGEN DISSOLVED OUT OF MIXED FERTILIZERS.

By Pepsin in 24 hrs.	In per cent. of total Nitrogen By Putrefaction in 145 days.			in 215 days.		
	No. of tests.	Extremes.	Average.	No. of tests.	Extremes.	Average.
80–90 p. c.	3	73–83 p. c.	77.0 p. c.	3	71–86 p. c.	79.9 p. c.
70–80 "	6	68–74 "	71.2 "	9	68–84 "	73.8 "
60–70 "	6	60–71 "	65.5 "	6	62–72 "	67.2 "
50–60 "	3	62–67 "	64.7 "	4	59–67 "	61.8 "
Under 50 "	2	52–58 "	55.0 "	1	....	54.5 "

IV. COMPARISON OF THE TESTS OF NITROGEN-SOLUBILITY WITH THE RESULTS OF VEGETATION-CULTURES IN 1893.

a. DESCRIPTION OF FERTILIZERS CHOSEN FOR THESE TRIALS.

Six samples were selected from those examined by the previously described tests, for a more thorough study of their nitrogen-solubility and also of their crop-producing power, and will be referred to as A, B, C, D, E and F.

E is a so-called "complete manure" which, judged simply by the solubility of its nitrogen in pepsin, would be above any suspicion.

D, a "ground bone," having reactions indicating the presence of leather and A, a "complete fertilizer" are of rather questionable value as far as their nitrogen-solubility is concerned. C, a "special potato manure" is even more suspicious; and B, a "flour of bone phosphate" is certainly condemned by the low solubility of its nitrogen in pepsin. To this series was added F, which, though it contained some leather, yet had a nitrogen-solubility of over 70 per cent. A 100 pound bag of this material had been received with the statement that it was leather, prepared by a special process, believed to render it available for plant food. Subsequent inquiry showed that it contained a good deal of tankage with some leather. The solubility of its nitrogen in pepsin first indicated to us that the article was better than originally represented.

b. PEPTIC DIGESTION OF THE ORIGINAL SAMPLES.

A considerable quantity of each of the materials just described was ground to pass a sieve with round holes $\frac{1}{50}$ inch in diameter,

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and each was a second time examined with reference to its nitrogen-solubility in pepsin solution with the subjoined results.

NITROGEN-INVENTORY AND DIGESTION OF THE ORIGINAL SAMPLES.

	A.	B.	C.	D.	E.	F.
Nitrogen as Nitrates*	---	1.65	---	---	.76	----
Nitrogen as Ammonia*	.89	.17	.08	---	---	----
Nitrogen, Organic*	2.12	1.29	3.40	3.57	2.78	10.24
TOTAL NITROGEN*	*3.01*	*3.11*	*3.48*	*3.57*	*3.54*	*10.24*
Per cent. of the Organic Nitrogen which is soluble in pepsin solution†	*55.2*	*41.1*	*49.1*	*63.8*	*85.6*	*82.40*
Organic Nitrogen insoluble in water*	1.87	1.15	2.84	3.05	2.44	6.58
Per cent. of the Organic Nitrogen insoluble in water, which is soluble in pepsin solution†	49.2	33.9	34.1	57.8	81.9	72.7

c. REMOVAL OF SOLUBLE NITROGEN FROM THE ORIGINAL SAMPLES. PREPARATION OF TEST SAMPLES.

Some of the materials contained nitrogen as nitrates or ammonia-salts. In order to test the crop-producing power of the *organic* nitrogen it was necessary to remove these soluble forms of this element.

A considerable quantity of each trial-fertilizer was therefore washed, first by decantation and then on filters, with cold water, till the washings were colorless and contained only the slightest traces of either sulphuric acid or chlorine.

By this means were removed all ammonia-salts and nitrates, as well as that portion of the organic nitrogen which was soluble in water.

The washed residues were dried at a temperature not above 90° F., thoroughly mixed and kept in securely stoppered bottles.

The determinations of total nitrogen and the solubility of the nitrogen in pepsin solution, of these prepared test samples, are given below.

NITROGEN-INVENTORY AND DIGESTION OF THE TEST SAMPLES.

	A.	B.	C.	D.	E.	F.
Total Organic Nitrogen*	3.30	2.38	5.73	4.17	4.43	10.03
Organic Nitrogen† soluble in pepsin	44.5	26.8	29.8	49.6	83.3	66.3

* Per cent. reckoned on Test Sample.

† Per cent. reckoned on Total Organic Nitrogen.

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These results on solubility, obtained from the washed residues of large quantities of material, confirm, in a general way, the results previously obtained with washed residues from a single gram of material.

d. Putrefaction of Test Samples.

The effect of putrefaction on the solubility of nitrogen in these washed samples was studied in the following manner.

Into narrow-necked flasks of about 500 c. c. capacity were weighed duplicate portions of each of the six materials under experiment, together with .12 grams of tobacco ash, which had been slightly acidified with phosphoric acid and dried. 300 c. c. of water from the city service pipes were added to each flask and the contents were boiled briskly for an hour. Before cooling, the necks of the flasks were filled with sterilized cotton plugs.

To each flask was next added .05 gram sodium carbonate, sufficient to neutralize any free acid and to give the contents an extremely slight alkaline reaction and finally was introduced 1 c. c. of a putrid extract from a mixture of rotting meat and manure.

The flasks were placed in a water-bath which was kept at a constant temperature of 100° F. during the day and allowed at night to sink to the temperature of the room, which did not vary much from 76° F.

From time to time the flasks were gently shaken and after twenty-one days their contents were filtered, and the residues, without washing, were brought back into the flasks with 300 c. c. of water and the same quantities of tobacco ash, sodium carbonate and putrefying solution as before and let stand for fifty-two days longer.

In the filtrates just mentioned were determined both the total nitrogen and that portion of it which was volatile when distilled with magnesium oxide. This volatile portion is designated "as ammonia" in the following tabulated statement.

To conclude the experiment, the contents of the flasks were again filtered, the residues were thoroughly washed and the filtrates with the washings were examined as above described. The nitrogen of the residues was also determined.

Following are the results. The duplicate tests are given in detail and the average of the two is stated in the general result.

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Solution of Organic Nitrogen during Putrefaction of Test Samples.

	A.		B.		C.		D.		E.		F.	
Total Nitrogen in Test Samples	3.30	3.30	2.38	2.38	5.73	5.73	4.17	4.17	4.43	4.43	10.03	10.03
After 21 days: Nitrogen in solution as Ammonia	.93	.90	.21	.21	1.19	1.23	.84	.82	1.72	1 96	3.28	3.12
" " " Organic	.25	.25	.16	.16	.32	.30	.66	.74	.41	.31	2.20	2.01
Total	1.18	1.15	.37	.37	1.51	1.53	1.50	1.56	2.13	2.27	5.48	5.13
Per cent. of the total Nitrogen gone into solution	*35.4*		*15.5*		*26.5*		*36.6*		*49.6*		*52.8*	
After 73 days: Additional Nitrogen in solution as Ammonia	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
" " " Organic	.12	.14	.09	.11	.16	.14	.06	.12	.08	.10	.11	.08
Total	.12	.14	.09	.11	.16	.14	.06	.12	.08	.10	.11	.08
Per cent. of total Nitrogen gone into solution since the previous filtration	*4.0*		*4.1*		*2.6*		*2.1*		*2.0*		*1.0*	
Total Nitrogen in solution as Ammonia	.93	.90	.21	.21	1.19	1.23	.84	.82	1.72	1.96	3.28	3.12
" " " Organic	.37	.39	.25	.27	.48	.44	.72	.86	.49	.41	2.31	2.09
" " not recovered*	.73	.82	---	.51	1.48	1.41	.48	.46	1.57	1.40	1.82	2.16
" " left undissolved	1.27	1.19	†	1.39	2.58	2.65	2.13	2.03	.65	.66	2 62	2.66
Per cent. of total Nitrogen in solution as Ammonia	27.6		8.8		21.1		19.9		41.5		31 9	
" " " Organic	11.5		10.9		8.0		19.4		10.1		21.9	
" " escaped*	23.7		21.4		25.3		11.2		33.4		19.8	
" " left undissolved	37.2		58.9		45.6		49.5		15.0		26.4	
	100.0		100.0		100.0		100.0		100.0		100.0	

* Escaped into the air as Ammonia or other gas. † Lost by accident.

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In these experiments, where every thing was favorable to bacterial growth, the putrefactive process was practically completed within three weeks. Very little more nitrogen was dissolved during the succeeding 52 days.

A very considerable quantity of nitrogen, amounting in one case to a third of the whole quantity in the flask, escaped from the flasks, whether altogether as ammonia or in some other gaseous form was not determined. The greater rapidity of the putrefactive process here as compared with that observed in the experiments described on page 225 is explained by the higher temperature, the presence of a nutritive solution which favored bacterial growth and possibly, by the use, in the last tests, of city water exclusively, in place of distilled water which has been claimed to be unfavorable to bacteria.

Comparing these results with the solubilities in pepsin, it appears that B was the least soluble. If we call the solubility of B in each case 100, the relative solubility of the others will be as follows :

	A.	B.	C.	D.	E.	F.
Relative Nitrogen-solubility in pepsin solution	166	100	111	185	311	247
" " under putrefaction	153	100	132	122	207	179

The two fertilizers most soluble in pepsin are most soluble under putrefaction, the one least soluble in pepsin is also least soluble under putrefaction, but there is no very close agreement in the results by the two methods.

The pepsin method is more convenient and rapid, the putrefaction method might be regarded as a nearer approach to the "natural" method by which organic nitrogenous matters are disintegrated in the soil and prepared for appropriation by plants. It is not certain, however, that putrefaction gives a better indication of the relative value of fertilizers, as a nitrogen supply to plants, than the pepsin method.

The question still remains whether either treatment is a proper criterion of the availability of the nitrogen of fertilizers.

e. Vegetation Cultures. Description of Method.

As a contribution to the answer of this question the following vegetation experiments were made during the summer of 1893. It is thought best to publish the results now although it is not claimed that they are absolutely decisive. It is hoped that experi-

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ment during the coming season may add more to our knowledge of the subject.

The general plan of these experiments was to test the crop-producing power of the organic nitrogen of the different fertilizers, by growing Indian corn with their aid, in pots filled with soil, that was of itself, nearly destitute of nitrogen available to the corn plant. These soils contained potash, phosphoric acid, and all the other elements of plant food, excepting nitrogen, in excess of the requirements of the crop, and were supplied, as required, with sufficient water. Four pots were devoted to each of the six fertilizers. To the soil in one of these four pots was added one decigram of organic nitrogen, supplied by the fertilizer under experiment. The second pot received two decigrams, the third pot four decigrams, and the fourth pot eight decigrams of organic nitrogen. After the crops in these pots had finished growing they were harvested separately, dried and weighed. The crop-producing power of the different fertilizers, is therefore measured and compared by the dry weights of these several crops. The details of the experiment here follow :

Pots.—The pots used were made of "galvanized" iron, wired on the upper edge. They were seven inches in diameter, nine inches deep, the bottom slightly concave, and in the center of the bottom was a hole with a collar $\frac{3}{4}$ of an inch in diameter, which could be closed with a rubber stopper. Each pot was supported on three iron legs, so that the lowest point of the collar referred to was $3\frac{3}{4}$ inches above the platform on which the pot stood. The general appearance of the pots may be seen by reference to the plate facing page 234.

The Artificial Soil consisted of sifted anthracite coal ashes, to which five per cent. of peat moss had been added. The coal ashes, fresh from the Station steam heater, were sifted through a wire sieve having square meshes, four to the inch. The ashes were perfectly neutral in reaction, and contained $\frac{6}{100}$ of one per cent. of nitrogen. The peat moss was from a fresh bale, which we are informed, is imported for stable bedding. It was sifted, and only that part was used which passed a sieve with about six meshes to the inch. This peat has a slight acid reaction, one gram neutralizing about .0033 grams of barium hydroxide. Distilled with magnesia, four grams yielded no trace of ammonia. The peat moss contains $\frac{49}{100}$ of one per cent. of nitrogen. This mixture of peat and ashes contained 18.4 per cent. of moisture and when saturated with water, held 101 per cent. of that liquid.

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The Supply of Fertilizer Ingredients.—Phosphoric acid was supplied in the form of Thomas slag and phosphatic guano. Four grams of the former and one gram of the latter, containing together .94 grams of phosphoric acid, were added to each pot and were more than sufficient to neutralize the acid reaction of the peat contained in the artificial soil. Potash was supplied to each pot in the form of one gram of muriate of potash.

Charging the Vegetation Pots.—After thorough washing and drying, each pot was fitted with a rubber stopper beneath and a piece of wire gauze over the hole in the bottom and washed fine quartz gravel was poured in, till the weight of the pot and contents was exactly 2000 grams. The layer of gravel was from $\frac{1}{4}$ to $\frac{1}{2}$ inch deep in the shallowest part.

At the side of each pot within was placed vertically a glass tube of about $\frac{1}{4}$ inch bore, planted below in the gravel and projecting about $\frac{1}{2}$ inch above the upper rim of the vessel. Into each pot were next poured 2000 grams of the artificial soil which had been already thoroughly intermixed with 5 grams of the phosphates before mentioned, and with the weighed amount of organic nitrogen designed for that pot, as well as with 100 grams of water—the whole charge being pressed down to the same level in all the pots. 100 c. c. of water, containing in solution 1 gram of pure potassium chloride, was poured slowly, without flooding, over the surface.

Water was then very carefully poured on the surface of each pot till the total weight of pot and contents was 5800 grams.

The pots were filled on the 25th of June. On the 27th, 5 kernels of "Early Minnesota" corn, a dwarf variety, were planted an inch deep and at the same distance apart in each pot. The seeds had been selected from near the butts of the ears and were very nearly uniform in weight.

150 grams of garden soil were shaken up with 1500 c. c. of water, and after the coarser particles had subsided 10 c. c. of the water-extract were added to each pot.

The soil having shrunk together somewhat, 300 grams more of artificial soil were added to each pot.

As soon as the maize plants were an inch high, two of them were extirpated and buried just below the surface of the soil, leaving three to grow.

In addition to the 24 pots which contained added nitrogen in the various forms and amounts already given, two pots were set

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up like the others in all respects except that no nitrogen was added to them beyond what was contained in the artificial soil.

Water.—The water used was from the city service pipes,* freed from all suspended matters by filtering through unglazed porcelain in the Pasteur-Chamberland Filter and was very pure, containing about 40 parts of total solids per million.

During the early stages of growth the water-content of the soil in the pots was brought to 35 per cent.—determined by weighing the pots—and then allowed to sink to 20 per cent. before watering again. It was soon seen that the plants suffered from lack of water, and thereafter the water-content was brought at each watering to 40 per cent. and not allowed to sink below 30 per cent. At each watering 100 c. c. of water were poured on the surface and the rest was supplied through the glass tube to the bottom..

The pots stood in a small greenhouse, which though not well suited for these experiments was the only safe place at our disposal. Large insects were excluded by netting. Constant care was required to prevent damage by small spiders.

As the bottom leaves of the plants died they were cut off and preserved in bottles suitably labeled and were weighed with the plants to which they belonged.

In these trials it was necessarily planned that the maize plants be furnished equally with all the requisites for healthy development, except that the nitrogen supply should be so decidedly less than the plants could utilize, that the dimensions and especially the weights of the crops would fairly indicate the relative availability of the nitrogen as well as the rate of its supply, in case of the several substances used as sources of this element.

The plants were, accordingly, small and imperfectly developed, because of their nitrogen-hunger; but they were entirely healthy and thrifty in appearance and, with few exceptions, put forth both "tassels" and "silk" (staminate and pistillate flowers). The latter it was attempted to fertilize, by use of the pollen from corn growing in the garden near by, but, as was doubtless to be reasonably expected, the flowers were in every instance abortive.

Accordingly, the great differences manifested in the growth of the crops in the several series, can only be explained by the differ-

*The water of Wintergreen Lake, filtered through paper, contained in June, 1890, 40.5 parts of total solids (of which 10 were lost by ignition), and 0.555 parts of nitrogen, per million.

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ences in the availability of the nitrogen supply. These differences are well illustrated by Plate III.

The following table gives in round numbers the quantities of water evaporated from the several pots and crops under experiment. The letters A, B, C, etc. refer to the six different fertilizers described on page 226. Four pots were supplied with nitrogen from each of these fertilizers and are numbered 1, 2, 3 and 4. In every case pot 1 received one-tenth of a gram of nitrogen, pot 2 two-tenths of a gram, pot 3 four-tenths of a gram and pot 4 eight-tenths of a gram of nitrogen. The gram nearly equals 15½ grains and 28⅓ grams make nearly an ounce avoirdupois.

WATER EVAPORATED FROM POTS AND PLANTS (grams).

Series,	A	B	C	D	E	F
Pot 1,.....	2270	2420	2740	2260	3550	3200
" 2,.....	4080	3570	4450	2470	5550	3830
" 3,.....	5900	4900	6790	3990	6220	6540
" 4,.....	9590	7000	8600	5710	9090	8200
Totals.....	21840	17890	22580	14430	24410	21770

When the plants had evidently ceased to increase, and new upper leaves were growing only at the expense of the old lower ones which had become yellow, shrunken and dry, the crops were harvested by cutting close to the soil.

The several crops were immediately dried at 120° F.; thereafter they were kept for 24 hours exposed to the air of a dry room and thus, in the air-dry state, were weighed with results as below given. These weights do not include the roots, which could not be separated from the soil.

WEIGHTS OF THE AIR-DRY CROPS (grams).

Series,	A	B	C	D	E	F	No nitrogen added.
Pot, 1,...	9.0	7.3	9.7	5.7	9.9	7.7	3.0 } av. 3.25
" 2,...	14.0	10.6	15.5	8.4	17.4	14.2	3.5 }
" 3,...	27.9	18.0	28.0	11.5	28.4	26.4	
" 4,...	48.2	27.0	45.4	23.6	44.4	33.8	
Totals ...	99.1	62.9	98.6	49.2	100.1	82.1	

The soil without any added nitrogen was thus shown to be able to produce 3¼ grams of dry substance, hence the net yield, which can certainly be attributed to the added organic nitrogen, is found by subtracting 3¼, say 3.3, from the gross weight of the several crops.

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PLATE III.

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The next tabular statement gives the quantities of crop-increase attributable to the organic nitrogen of the several fertilizers under trial.

WEIGHT OF AIR-DRY CROP-INCREASE (in grams).

Series,	A	B	C	D	E	F
Pot 1,.....	5.7	4.0	6.4	2.4	6.6	4.4
" 2,.....	10.7	7.3	12.2	5.1	14.1	10.9
" 3,.....	24.6	14.7	24.7	8.2	25.1	23.1
" 4,.....	44.9	23.7	42.1	20.3	41.1	30.5
Totals.....	85.9	49.7	85.4	36.0	86.9	68.9

The proportionate quantities of nitrogen added to the four pots in each series were to each other as the numbers 1, 2, 4, 8. The next table exhibits the proportionate increase of crop produced by the several applications of nitrogen—the increase of the first pot of each series being taken as 1.

RELATIVE CROP-INCREASE DUE TO NITROGEN ADDED.

	Relative quantities of nitrogen added.	Series,	A	B	C	D	E	F
Pot 1,.....	1		1	1	1	1	1	1
" 2,.....	2		1.9	1.8	1.9	2.1	2.1	2.5
" 3,.....	4		4.3	3.7	3.9	3.4	3.8	5.3
" 4,.....	8		7.9	5.9	6.6	8.5	6.2	7.0

The above table shows that, as was intended, the nitrogen in all these experiments was present in minimum quantities relative to the other needful elements of plant food, so that the crop-increase kept fairly parallel with the increase of nitrogen. Larger supplies of nitrogen would have increased the crop still more but a point would soon have been reached, where the crop-increase would lag behind the increase of nitrogen in the fertilizer, till finally, increasing the nitrogen would have no further effect on the weight of crop, because some other kind of plant food would come to be in relative minimum and would thenceforth limit the development of the plants.

The increased yield due to the nitrogenous fertilizer is greatest in series E. If we reckon the yield in series E, in each case, as 100 then the *relative yields* produced by the several fertilizers are as follows:—

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CROP-INCREASE STATED IN PER CENT. OF GREATEST GAIN.

Series,	A	B	C	D	E	F
Pot 1,	86	61	97	36	100	66
" 2,	76	52	87	36	100	77
" 3,	98	58	98	33	100	92
" 4,	109	57	102	49	100	74
Average,	**92**	**57**	**96**	**39**	**100**	**77**

So far as these experiments are a correct measure, the relative crop-producing power of the several fertilizers is expressed by the last average figures above given.

If the crop-increase is a fair measure of the effect of the organic nitrogen used to fertilize the soil of the pots in which these crops were produced, then the quantities of nitrogen contained in the crops, especially in so far as derived from the fertilizers, ought to stand closely related to and parallel with the weights of the crops. To what extent such is the case, is to be seen from the following tables :—

QUANTITIES OF NITROGEN IN THE CROPS (grams).

	A	B	C	D	E	F	*No nitrogen added.*
Pot 1,	.044	.036	.052	.030	.048	.041	.017 } av. 0185
" 2,	.077	.058	.079	.047	.078	.067	.020 }
" 3,	.148	.099	.137	.067	.151	.114	
" 4,	.270	.178	.304	.142	.275	.193	
Totals,	.539	.372	.572	.286	.552	.415	

Deducting from the above figures, the average amount of nitrogen in the two crops raised in the pots to which no fertilizer, (and no nitrogen) was added, we obtain the weights of—

NITROGEN-INCREASE IN THE CROPS (grams).

	A	B	C	D	E	F
Pot 1,	.026	.018	.034	.012	.030	.023
" 2,	.059	.040	.061	.029	.060	.049
" 3,	.130	.081	.119	.049	.133	.096
" 4,	.252	.160	.286	.124	.257	.175
Totals,	.467	.299	.500	.214	.480	.343

RELATIVE NITROGEN-INCREASE IN CROPS.

	Relative amounts of nitrogen added.	Series,	A	B	C	D	E	F
Pot 1,	1		1	1	1	1	1	1
" 2,	2		2.3	2.2	1.8	2.4	2	2.1
" 3,	4		5.0	4.5	3.5	4.1	4.4	4.2
" 4,	8		9.7	8.9	8.4	10.3	8.6	7.6

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NITROGEN-INCREASE STATED IN PER CENT. OF GREATEST GAIN.

Series,	A	B	C	D	E	F
Pot 1,	87	60	113	40	100	76
" 2,	98	66	·101	48	100	82
" 3,	98	61	89	37	100	72
" 4,	98	62	111	49	100	68
Average,	95	62	104	44	100	75

Comparing the last four tables with the four immediately preceding ones, it is manifest that the Crop-Increase and Nitrogen-Increase kept very even pace. This is also shown by the averages of increase in the table above and in the following:

In the subjoined table are brought together in one statement the nitrogen-solubilities in pepsin and under putrefaction, and the nitrogen-availabilities, of the several fertilizers, as indicated by gain of crops and gain of nitrogen in crops, all expressed in per cent. of the solubility or availability of the nitrogen in the best fertilizer E.

COMPARISON OF PEPTIC, PUTREFACTIVE AND CULTURE TESTS.

	A	B	C	D	E	F
Relative nitrogen-solubility by pepsin	53	32	36	59	100	79
" " " " putrefaction	74	48	64	60	100	87
Relative crop-producing power	92	57	96	39	100	77
" gain of nitrogen	95	62	104	44	100	75

The nitrogen of sample E shows throughout the greatest peptic and putrefactive solubility as well as greatest crop-producing capacity and with one exception (C) has given the most nitrogen to the crops. Sample B has yielded the least soluble nitrogen to pepsin and under putrefaction, but D, in the culture test, is least effective as a fertilizer. Samples A, C and E which vary so widely in the peptic and putrefactive solubility of their nitrogen, manifest very little difference in their average crop-producing powers as measured by either the crop-increase or gain of nitrogen by the crops.

It is evident that the tedious vegetation-cultures are the only true test of the availability of organic nitrogen, while the pepsin-digestion may give useful indications, but cannot be depended on for decisive results.

If opportunity offers it is purposed to continue investigations in these or similar directions.

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FEEDING STUFFS.

(For Tables of Analyses see pages 248 to 251.)

Hay from Wheat and Rye.

Regarding these samples of hay, Mr. E. C. Birge of Southport writes that to provide enough coarse feed for his herd he finds advantage in raising rye or wheat to be cured for hay, immediately following and preceding his corn or other hoed crop and on the same land. By this means a crop covers the land the whole year round, and is growing at all seasons when the ground is not frozen. Mr. Birge judges that he thus gets more coarse fodder for winter use than is possible in any other way.

The hoed land is manured whenever convenient, summer or winter. The fields where corn was cut in September, 1893, and which were then seeded to rye, were manured in the succeeding winter and bushharrowed and rolled in the spring of 1894, to lay down the corn stubble and prevent its interference with cutting the rye in early June. The land will then be turned over and planted to corn. Common pasture land, after three successive corn crops with rye or wheat between, is seeded to clover.

After clover, corn or potatoes and rye or wheat follow again.

4124. Wheat-Hay, sowed Sept. 20, 1892, after potatoes, top-dressed in the winter, cut June 24th, when the seed was just going into the dough stage. Cured in good order and put into the barn June 30. The stubble was immediately turned under for corn. Yield about 2 tons per acre.

4126. Rye-Hay, sowed Sept. 6, 1892, after corn. Cut June 3d, 1893, cured in good order and put into barn June 6th. Yield about 1½ tons per acre.

4125. Rye-Hay, sowed Sept. 28, 1892, after corn which yielded 24 tons per acre. Cut June 8, 1893, cured in good order and put in barn June 10. Yield about 2 tons per acre.

4127. Rye-Hay, sowed after corn Oct. 11, 1892. Cut May 22, 1893, to clear the ground for corn. This was poorly cured, rained on while spread. Yield about one ton per acre.

The analyses, on pages 248–249, indicate that these cereal crops cured as hay, have, with the exception of **4127**, rather less protein and more fiber than average hay from mixed meadow grasses.

The higher content of protein in **4127**, as well as its smaller yield per acre, are explained by the fact that it was cut earlier than the other lots.

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Maize Meal.

4132 is made from No. 2 old crop yellow corn in a roller mill.

4134 is made from new yellow corn in a roller mill.

Both of the above were drawn from stock of S. E. Brown, Collinsville.

4133 is made from old mixed corn ground on burr stones, sent by S. E. Brown, Collinsville.

4107, 4108 and **4109** are samples of meal drawn by our agent from stock of B. H. Palmer & Son, Norwich, Hatch, Bailey & Co. and Raymond Bros., of South Norwalk.

By-Products from Maize Meal.

These feeding stuffs mostly come from the factories of starch and glucose, of which the five largest in the United States together are said to be able to work up 120,000 bushels of corn daily. Glucose is made by chemical treatment of starch.

The preliminary processes by which the starch is separated from the other parts of the kernel are essentially the same in all factories, and are stated by the representative of one of them to be as follows:

The corn is ground with water between stones and first passed over sieves which retain the hull or chaff, while the starch mixed with the so-called "gluten" runs to settling tanks. The starch being specifically heavier than the gluten sinks to the bottom, while the gluten lies above the starch. When both have completely settled, the clear water first, and next the gluten, are run off, leaving the starch.

The Chicago Sugar Refining Co., of Chicago, Ill., makes Chicago Gluten Meal, Maize Feed and Corn Bran. The Chicago Gluten Meal is the clear "gluten" from the settling tanks, dried and perhaps ground. It is a granular, yellow or yellowish-brown material without decided odor. A single analysis is given, **4102.** It is a highly nitrogenous feed, nearly as rich in protein as cotton-seed meal, but containing much less fat or oil and but very little mineral matter. Its use in cattle rations would be about the same as that of cotton-seed meal. The Chicago Maize Feed is a mixture of gluten meal and hulls, not dissimilar from Buffalo Gluten Feed.

The Chicago Corn Bran, of which a single analysis, **4103,** is given in the table, consists of the hulls left on the sieves and of the corn chits or germs from which the oil has been partly extracted.

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This material, as the analysis shows, has rather more protein than maize kernels of good quality and more than twice as much fat with correspondingly less nitrogen-free extract. Probably it cannot be economically used by feeders who have a plenty of home-raised corn.

The Charles Pope Glucose Co., of Geneva and Venice, Ill., make Cream Gluten Meal and Germ Feed. This brand of Gluten Meal is made of the "gluten" of the settling tanks like the Chicago Gluten. It is like the latter in appearance, has about the same percentage of protein, but twice as much oil as the Chicago Gluten Meal, and so compares more nearly with cotton-seed meal in composition. Two analyses appear in the table, **4084, 4106,** the former from stock of Smith, Northam & Co., Hartford. Cost $25.00 per ton.

Pope's Germ Feed is very like the Chicago Corn Bran in its origin and composition. See analysis **4105.**

The American Glucose Co., of Buffalo, N. Y., and Peoria, Ill., which is by far the largest company in the business, makes but one kind of feed, sold under the name Buffalo Gluten Feed. It consists of all those parts of the kernel not directly used to make glucose and contains therefore all the "gluten," hulls and oil of the kernel. Two analyses appear in the table, **4104** and **4069,** the latter sent by T. S. Gold, West Cornwall. It cost $20.00 per ton in car lots, in bags, delivered at West Cornwall.

This gluten feed is a more concentrated food than wheat bran, containing some 6 per cent. more of protein and two to three times as much oil as the latter, and more non-nitrogenous extract with less fiber and mineral matter.

Two samples of Hominy Chops, **4129** from F. H. Stadtmueller of Elmwood, and **4145** sent by Horace Burr of Winchester Center and bought of Noble Bennett, Winsted, both residues from the manufacture of hominy, are included in the table.

Wheat Feeds.

Three analyses of winter wheat bran, Nos. **4096, 4097** and **4098,** from stock of Browning & Gallup, New London, E. A. Buck & Co. and W. D. Grant of Willimantic, are given in the table; and two of spring wheat bran, Nos. **4099** and **4100,** from J. W. & F. J. Doon, Willimantic, and Arnold Rudd of New London.

While single analyses of winter wheat bran and spring wheat bran may show some variations, the averages of large numbers of analyses prove no constant difference in composition between the two.

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White Wheat Bran **4110**, Red Wheat Bran **4111**, both from stock of Spencer & Pierpont, Waterbury, and Canada Bran **4112**, from stock of W. T. Hatch, South Norwalk, are preferred by some but they do not vary essentially in composition from the ordinary kinds. Whether the fineness of bran affects its digestibility is a question frequently asked but which has never, to our knowledge, been the subject of feeding experiments.

In the table are given five analyses of Wheat Middlings:

4091 and **4095** are from stock of Arnold Rudd, New London, **4092** from A. O. Beckwith, Norwich, **4093** from Smith & Northam, Hartford, and **4094** from B. H. Palmer & Son, Norwich. There is no great difference in chemical composition between these feeds and bran. They are a little richer in protein and are much more finely ground and lighter colored than the brans.

4089 from Hatch, Bailey & Co., and **4090** from M. T. Hatch, both of South Norwalk, are "Fine Wheat Feeds." These differ essentially from wheat bran and middlings. They are fine, white and floury, have comparatively little mineral matter and fiber and correspondingly more nitrogen-free extract. The quantities of protein and also of fat are not different from those of bran and middlings.

Oats and Oat Feeds.

The analyses made on samples drawn in the Connecticut market show the wide variations which are constantly met with in all preparations of oats used for cattle food.

The ground oats **4136** have the composition of clear oats.

The "Oat Feed" and "Oat Middlings" we are informed are made by the American Cereal Co. We have been unable to learn whether brands of definite composition and quality are put on the market by this company, but it is certain that "Oat Feed" is a general name in the feed market which is applied to fine feed rich in protein and also to chaffy coarse feed that is much poorer in protein than clear oats.

The samples of Oat and Corn Feed **4137** and **4138** are of inferior value, containing less protein than either corn or oats of good quality.

Rye, Barley and Buckwheat Feeds.

4146, Buckwheat Flour sent by T. F. Griswold, Little Haddam, is used for the table and not for cattle food. It has the

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average composition of the article, is low in protein (5.8 per cent. as against 10.8 in wheat flour), and correspondingly richer in starchy matter (80.5 per cent. as against 75 per cent. in wheat flour).

Strikingly different in composition is the buckwheat bran **4076** sold by W. F. Olmstead of Bridgeport. This must be the residue left from preparing the flour from the *hulled* seeds. It is rich in proteids (25.62 per cent.), containing more than wheat bran or Buffalo Gluten Feed and contains also as much fat as bran. At $19.00 per ton it should be a very economical feed, *judged simply by its chemical composition.*

4147, Buckwheat Feed sent by F. W. Holmes, Salisbury, from Eggleston & Sellick's mill, is a product evidently containing a good deal of the hulls mixed with the bran, as is shown by the large quantity of "fiber" in it. It contains rather more proteids, however, than corn meal.

The sample of ground rye **4130** was sent by F. H. Stadtmueller of Elmwood. There is no evident reason why clean rye may not be fed to cows in the same quantity as corn meal. The composition of the two is not very unlike.

The suspicion with which rye is regarded by feeders probably comes from the fact that when it is affected with ergot, as sometimes happens in very wet seasons, its use as a feed is unsafe.

The presence of ergot in rye can be readily detected by the eye.

Two analyses of "Damaged Barley," **3782** and **4054,** represent grain which had been malted and probably overheated in the kiln so that it could not be used for brewing. The samples had a slightly scorched smell. The process of malting merely brings the starch and other matters of the seeds into more soluble form but does not destroy or remove any considerable part of them.

This feed has been used in considerable quantity by several feeders in the State with good results. Cows relish it and it imparts no noticeable ill flavor to the milk.

Cotton Seed Meal.

Samples **4073** from Wheeler & Howes, Bridgeport; **4074** from A. A. Beckwith, Norwich; **4075** from Wm. M. Terry & Co., Bridgeport; **4143** and **4144** sent by Clarence A. Hammond, Elliott, and purchased of the Charlotte Oil and Fertilizer Co., Charlotte, N. C., represent the average quality of clear decort

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cated meal, the most concentrated feeding stuff in the market and, if used solely as a fertilizer, the cheapest source of available organic nitrogen.

3856 is undecorticated Sea Island Meal, containing little more than half as much proteids as the hulled meal and, at present prices, very uneconomical to purchase either as feed or fertilizer.

Linseed Meal, Old and New Process.

Much of the linseed meal in market is the pulverized cake left after ground flax-seed has been subjected to extreme pressure for extraction of the oil. This "Old Process" meal retains from 5 to 11 per cent. of oil. The Cleveland Linseed Oil Co. controls patents for removing the oil by solvents instead of pressure. Their Linseed Meal, called "New Process," contains much less oil and more protein than the other. **4080** is from the Platt Mill Co. of Waterbury, **4081** from E. A. Buck & Co., Willimantic, **4082** from Wheeler & Howes, Bridgeport, **4083** from A. A. Beckwith, Norwich, and **4128** was sent by F. H. Stadtmueller, Elmwood.

Pea Meal.

3746, sent by T. S. Gold, West Cornwall, probably consists of the shells or outer coating of peas, ground with other refuse, from a split-peas factory. Cows do not relish this meal on account of its bitter taste and even sheep prefer bran.

Miscellaneous Feeds.

"Proteina," of which two analyses are given, **4078** from stock of Browning & Gallup, New London, **4079** from E. A. Buck & Co., Willimantic, appears to be a mixture of corn, oat hulls, linseed meal and perhaps gluten meal.

It may be most fairly compared, as far as chemical composition goes, with Buffalo Gluten Feed, but its price is, at present rating, too high to make it an economical feed.

Special Cow Feed **4077** sold by Hatch, Bailey & Co., South Norwalk, is said to be composed of 40 pounds of gluten meal, 40 pounds of hominy chops, 15 pounds of oats and 5 pounds of linseed meal in every 100 pounds.

Assuming that the "gluten meal" of the formula is gluten *feed* with 22 per cent. of proteids instead of 36 or 38, such a formula ought to make a considerably richer feed, containing some 4 per cent. more of protein than is in the sample.

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3748 is a sample of Special Made Mill Feed of the United States Milling Co., Jersey City, N. J., which it is claimed "will keep sound and sweet longer than any in the market, thereby insuring those who handle this feed a better return for their money than any other feed."

The analysis shows it to be a less concentrated feed than wheat bran. In the circular received from the manufacturer nothing is stated as to the ingredients which enter into this "special made feed."

4072 is a sample of Elevator Screenings sent by W. L. Buckland of Burnside. It is used chiefly as poultry food but to some extent for cattle. It is to be judged rather by inspection than chemical analysis. It consists of damaged grain mixed with seeds of cockle and a host of other weeds. Its use either for poultry or cattle makes pretty certain a further seeding of the farm with noxious weeds.

4122 is a sample of "Nutriotone" made by the Thorley Food Co. of Chicago, Ill., and widely advertised and sold in Connecticut at the present time. It contains a considerable quantity of some leguminous seed, some linseed meal and perhaps other feeding stuffs, together with aromatic substances, (fenugreek, aniseseed, caraway and the like), and over ten per cent. of salt. The analysis shows its value in a general way *as a feed.* The material however is claimed to be rather in the nature of a tonic having medicinal properties, than of a feeding stuff, as is judged from the fact that the prescribed dose for cattle is two tablespoonfuls with each feed. The use of such condimental cattle foods has been proved by Sir John Lawes to be without any advantage for healthy animals, as shown by the following quotation from the Second Annual Report of this Station for the year 1878, pp. 125–6 :

"Mr. Lawes, of Rothamsted, England, made a most thorough practical trial on the use of condiments in feeding, and demonstrated that there was no profit in it. One of his trials was made on twenty sheep (ten fed with plain food, ten with condiment) and continued twenty-eight weeks, when the animals were slaughtered and marketed. The extra cost of feeding ten sheep with condiment was £3, 4s., the result of the feeding being alike with condiment and with plain food."*

* Experiments on the Question whether the use of Condiments increases the Assimilation of Food by Fattening Animals, or adds to the Profits of the Feeder: by J. B. Lawes, F.R.S. Edinburgh Veterinary Review, 1862.

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"Mr. Lawes has stated* that while sheep ate no more food under the stimulus of condiments than without, pigs did eat a larger quantity, but the pigs assimilated no more and got no benefit from the increased consumption."

"Other testimony to the same effect may be found in the agricultural journals of Great Britain, where condimental foods were extensively tested fifteen to twenty years† ago."

Here may also be noticed the Silver Live Stock Powder, which is sold in this State for $1.00 per pound. According to the advertising circular the "Silver Live Stock Powder contains an element that the nature of animals require, from which the habits of civilization have deprived them."

"Formerly when an animal was sick, the first thing to know was the name of the disease and then to find a remedy. Since the discovery of the Live Stock Powder or Nature's Sovereign Remedy," the writer goes on to say that he does not care to know what the ailment is.

The "Sovereign Remedy" consists essentially of ground bone, having a dark color and slight odor of coal tar.

The Valuation of Mill Feeds.

In a following table are given the average cash ton prices of the mill feeds commonly found in our markets. These figures are based on quotations made to us by twenty-two leading feed dealers of this State in December last.

From the average composition of the different feeds and their cost, has been calculated, by the method described in the Report of this Station for 1888, page 141, the average cost per pound of protein, fat, etc.

It was found that at present prices the average cost of these ingredients in mill feeds is as follows:

Protein costs	2.3	cents per pound.
Nitrogen-free Extract and Fiber	.94	" "
Fat	1.14	" "

The following table gives the articles on which this calculation was based, the market prices of these articles, and their "valuation" calculated from the average cost of the food ingredients:

* Journal Royal Agricultural Society of England, xxiii., p. 425.

† Now thirty to forty years ago.

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	Average cost per ton.	Valuation per ton.
Cotton Seed Meal	$27.50	$27.96
Linseed Meal, old process	29.75	25.12
Linseed Meal, new process	28.25	24.83
Wheat Bran	18.75	20.13
Wheat Middlings	20.50	21.46
Rye Bran	20.00	20.24
Corn Meal	20.50	18.24
Gluten Meal	25.50	27.93
Hominy Chops	20.00	19.27
Malt Sprouts	18.50	22.14
Oat Feed	21.00	20.12
Buffalo Gluten Feed	21.25	23.85
	$271.50	$271.29

The sums total of the cost prices and valuations are very nearly alike, proving the correctness of the calculation by which the costs of protein, fat, etc., were obtained.

Similar calculations made in 1888 and in 1890 gave the following as the cost of the ingredients named :

	1888.	1890.	1893.
Protein (N × 6.25)	1.6 cents per pound.	1.4	2.3
Fat	4.2 " "	2.9	1.14
Nitrogen-free Extract and Fiber	.96 " "	1.4	.94

The same feeds, with one or two exceptions, were used in the calculations of the three years and the chemical analyses were essentially the same. Hence these wide variations in cost prices of protein, fat, etc., are chiefly to be explained by changes in the relative cost of highly nitrogenous feeds as compared with the more starchy ones.

The prices of feeds in our market bear no relation at present to their relative value as cattle food. It is a striking commentary on the situation that the most concentrated of our feeding stuffs is also the cheapest source of organic nitrogen as a fertilizer. The quantity of cotton seed meal used as a feed in this State is very much less than the quantity used as manure.

By the use of the above schedule of prices may be calculated the "valuation" of certain feeds. The schedule is *only applicable to mill feeds* of the same general kind as those named in the table; it is not applicable to coarse fodder, roots, etc.

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Such a "valuation" does not have any reference to the digestible substance or to the feeding value of the article. It simply serves to show whether the crude food ingredients contained in the feed cost more or less than the general average of mill feeds.

Thus from the valuations in the following table of analyses it appears that when clear cotton-seed meal is quoted at $26 to $27 per ton its crude food ingredients cost less pound for pound than those of mill feeds on the average, but that in undecorticated meal at $22.50 the crude food ingredients cost as much as in ordinary mill feeds or even more.

Judged in the same way the crude food ingredients of linseed meal are more costly than in most other feeds, and the same is true of the samples of "provender" whose analyses and valuations are given on pages 250 and 251.

Yet linseed meal ought not to be discarded simply because its crude food ingredients cost more in our market than those of other feeds. Many experienced feeders claim that it is actually worth more both because of its nutritive value and also because of its regulative and medicinal effect on the digestive system. While the food ingredients of cotton seed meal are cheaper than those of other feeds, the nature of the feed places strict limitations on its use, particularly for dairy stock.

The indications which this "valuation" furnishes are, however, suggestive, and may be helpful in studying the chemical analyses in the table.

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Cost, Valuation and

Number.		Cost per Ton.	"Valuation."
4124	**Wheat Hay**	----	----
4126	**Rye Hay**	----	----
4125	"	----	----
4127	"	----	----
4132	**Maize Meal**	----	$19.02
4134	"	----	17.93
4133	"	----	18.61
4107	"	$20.00	19.06
4108	"	23.50	18.89
4109	"	22.00	19.12
	By-Products from Maize Meal.		
4102	Chicago Gluten Meal	----	27.93
4103	Chicago Corn Bran	----	20.57
4084	Pope's Cream Gluten Meal	25.00	28.13
4106	Pope's Cream Gluten Meal	----	27.47
4105	Pope's Germ Feed	----	20.82
4104	Buffalo Gluten Feed	----	24.42
4069	Buffalo Gluten Feed	20.00	23.18
4129	Hominy Chops	----	19.57
4145	Hominy Chops	20.00	19.25
	Wheat Feeds.		
4096	Winter Wheat Bran	18.00	20.35
4097	" "	20.00	20.10
4098	" "	18.00	20.52
4099	Spring Wheat Bran	18.00	20.12
4100	" "	19.00	20.04
4110	White Wheat Bran	20.00	19.78
4111	Red Wheat Bran	19.00	20.36
4112	Canada Bran	20.00	19.63
4101	Bran	18.50	20.20
4094	Red Middlings	20.00	21.17
4091	Winter Wheat Middlings	21.00	21.94
4092	" " "	23.00	22.02
4093	Spring Wheat Middlings	19.00	21.36
4095	" " "	21.00	20.98
4089	Fine Wheat Feed	22.00	21.31
4090	" " "	22.00	21.56

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Analyses of Feeding Stuffs.

Analyses.						Analyses, Calculated Water-Free.				
Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract, (Starch, Gum, etc.)	Fat.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract, (Starch, Gum, etc.)	Fat.
11.29	3.10	4.61	30.25	49.36	1.39	3.49	5.18	34.11	55.65	1.57
10.24	4.02	5.81	38.36	40.28	1.29	4.46	6.47	42.74	44.88	1.45
9.52	3.83	5.21	37.68	42.22	1.54	4.23	5.77	41.66	46.65	1.69
10.27	5.28	6.71	37.83	38.67	1.24	5.89	7.46	42.18	43.09	1.38
12.47	1.04	9.57	1.50	71.41	4.01	1.18	10.94	1.71	81.60	4.57
16.57	.65	8.20	1.78	69.37	3.43	.78	9.82	2.13	83.17	4.10
14.08	1.07	9.17	1.97	69.72	3.99	1.23	10.70	2.30	81.12	4.65
12.30	1.08	9.62	1.41	71.59	4.00	1.22	10.96	1.60	81.66	4.56
12.50	1.00	9.12	1.25	72.37	3.76	1.14	10.41	1.42	82.74	4.29
12.18	1.08	9.75	1.82	71.19	3.98	1.23	11.11	2.07	81 06	4.53
8.43	.62	38.94	.85	45.14	6.02	.68	42.52	.94	49.29	6.57
8.24	.40	11.19	12.10	59.22	8.85	.44	12.19	13.17	64.56	9.64
8.49	.65	38.56	1.12	37.27	13.95	.70	42.13	1.21	40.71	15.25
6.84	.55	35.00	1.00	43.21	13.40	.59	37.57	1.07	46.38	14.39
7.26	.50	11.25	12.49	58.04	10.46	.54	12.14	13.46	62.57	11.29
8.04	.40	24.87	7.45	48.16	11.08	.43	27.05	8.11	52.37	12.04
11.58	.67	22.62	6.83	44.93	13.37	.75	25.59	7.71	50.82	15.13
10.93	2.55	11.12	4.29	64.01	7.10	2.86	12.49	4.83	71.91	7.91
11.66	2.65	10.35	5.20	61.93	8.21	3.00	11.72	5.88	70.10	9.30
11.34	6.55	17.31	8.40	51.19	5.21	7.39	19.52	9.48	57.74	5.87
11.35	6.40	16.31	11.02	49.99	4.93	7.22	18.40	12.43	56.40	5.55
11.30	6.03	17.62	7.50	53.00	4.55	6.80	19.87	8.46	59.75	5.12
11.75	6.25	16.56	10.08	50.42	4.94	7.08	18.77	11.42	57.13	5.60
10.84	6.81	16.12	10.42	51.59	4.22	7.62	18.08	11.69	57.88	4.73
10.50	6.45	14.62	8.18	56.17	4.08	7.20	16.33	9.16	62.75	4.56
9.97	6.40	16.37	8.73	53.91	4.62	7.11	18.19	9.69	59.88	5.13
11.04	6.95	14.87	8.61	54.26	4.27	7.81	16.72	9.67	61.00	4.80
11.21	6.56	16.69	10.22	50.37	4.95	7.39	18.79	11.51	56.73	5.58
9.37	4.27	17.31	7.87	55.49	5.66	4.72	19.09	8.67	61.23	6.29
11.37	2.87	20.69	3.02	57.71	4.34	3.30	23.33	3.39	65.10	4.88
10.50	3.75	20.94	4.20	55.48	5.13	4.18	23.40	4.69	62.00	5.73
9.92	4.99	18.87	7.00	53.46	5.76	5.54	20.93	7.80	59.34	6.39
11.59	3.00	17.43	3.87	59.64	4.47	3.39	19.72	4.38	67.45	5.06
11.90	1.40	17.69	.85	63.24	4.92	1.59	20.08	.95	71.80	5.58
12.09	1.45	18.87	1.40	61.89	4.30	1.64	21.47	1.59	70.41	4.89

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Cost, Valuation and

Number.		Cost per Ton.	"Valuation."
	Oats, Oat Feed and Provender.		
4136	Clear Ground Oats	----	$19.72
4139	Oat Feed	----	19.66
4140	"	----	20.22
4141	Oat Middlings	----	22.28
4086	Provender	$22.00	19.28
4087	"	24.00	19.23
4088	"	24.00	19.09
4137	Oats and Corn Feed	----	18.54
4138	" "	----	18.78
	Rye, Barley and Buckwheat Feeds.		
4146	Buckwheat Flour	----	----
4076	Buckwheat Bran	19.00	22.92
4147	Buckwheat Feed	16.00	19.49
4130	Ground Rye	----	19.00
4085	New York State Rye Feed	20 00	20.49
3782	Damaged Barley	14.50	20.34
4054	Damaged Barley	----	19.37
4073	**Cotton Seed Meal,** decorticated	27.00	26.70
4074	" " "	27.00	28.43
4075	" " "	27.00	30.34
4143	" " "	26.00	28.53
4144	" " "	26.00	28.16
3856	" " undecorticated	23.50	22.53
4080	**Linseed Meal,** Old Process	30.00	25.19
4081	" "	31.00	25.85
4082	" "	31.00	24.21
4083	" New Process	33.00	26.59
4128	" "	----	25.84
3746	**Pea Meal**	20.00	22.12
	Miscellaneous Articles.		
4078	Proteina	25.00	23.33
4079	Proteina	24.00	23.46
4077	Special Cow Feed	24.00	20.37
4135	Pratt's Food for Horses and Cattle	----	20 83
3748	U. S. Milling Co.'s Special Mill Feed	21.00	21.03
4072	Elevator Screenings	12.00	----
4122	Nutriotone	----	----

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Analyses of Feeding Stuffs—*Continued.*

Analyses.						Analyses, Calculated Water-Free.				
Water.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.	Ash.	Protein.	Fiber.	Nitrogen-Free Extract. (Starch, Gum, etc.)	Fat.
9.67	3.29	11.53	11.12	58.83	5.56	3.65	12.77	12.31	65.12	6.15
8.88	4.43	11.94	14.02	57.76	2.97	4.86	13.11	15.39	63.37	3.27
7.89	4.04	12.81	13.05	57.78	4.43	4.37	13.90	14.19	62.72	4.82
6.52	3.40	18.45	5.13	58.32	8.18	3.64	19.74	5.49	62.38	8.75
12.24	1.05	10.31	3.20	68.93	4.27	1.21	11.76	3.66	78.50	4.87
12.20	1.10	10.13	3.32	68.75	4.50	1.25	11.54	3.78	78.30	5.13
12.37	.95	9.62	2.70	69.87	4.49	1.09	10.97	3.08	79.74	5.12
10.10	2.85	7.51	10.35	65.84	3.35	3.17	8.33	11.52	73.25	3.73
10.08	2.77	8.28	9.38	65.98	3.51	3.06	9.19	10.41	73.45	3.89
12.08	.91	5.79	.25	80.48	.49	1.05	6.59	.28	91.52	.56
12.84	3.53	25.62	3.72	48.45	5.84	4.04	29.40	4.27	55.59	6.70
10.67	2.79	11.43	28.66	43.69	2.76	3.13	12.79	32.08	48.90	3.10
13.21	1.70	10.75	2.25	70.07	2.02	1.96	12.38	2.58	80.76	2.32
10.31	2.80	14.87	3.60	65.68	2.74	3.12	16.58	4.01	73.24	3.05
7.48	2.17	12.06	6.15	70.29	1.85	2.35	13.03	6.65	75.97	2.00
11.88	2.19	11.56	5.60	66.87	1.90	2.49	13.12	6.36	75.87	2.16
8.92	7.25	38.56	4.38	29.68	11.21	7.95	42.34	4.81	32.59	12.31
8.58	6.63	44.56	5.25	25.71	9.27	7.25	48.77	5.74	28.14	10.10
8.35	5.52	50.38	3.90	20.74	11.11	6.03	54.97	4.25	22.63	12.12
9.64	6.40	45.44	4.37	24.45	9.70	7.08	50.30	4.82	27.07	10.73
9.92	6.74	44.56	5.23	24.18	9.37	7.49	49.46	5.81	26.84	10.40
10.08	5.00	23.19	18.39	36.86	6.48	5.56	25.79	20.45	41.00	7.20
10.34	5.37	33.06	7.87	34.55	8.81	5.99	36.87	8.78	38.54	9.82
10.99	5.12	36.31	7.30	35.24	5.04	5.75	40.80	8.20	39.59	5.66
9.03	4.40	27.69	8.50	40.22	10.16	4.83	30.44	9.34	44.22	11.17
10.45	5.42	39.19	7.60	34.49	2.85	6.05	43.76	8.49	38.52	3.18
11.76	5.37	37.25	9.06	33.42	3.14	6.10	42.20	10.27	37.87	3.56
12.40	3.66	23.13	8.89	50.74	1.18	4.17	26.42	10.15	57.92	1.34
9.80	2.03	23.50	8.47	47.20	9.00	2.25	26.06	9.34	52.35	10.00
9.56	2.37	24.06	9.42	45.66	8.93	2.63	26.60	10.39	50.50	9.88
10.68	1.86	13.56	6.77	61.03	6.10	2.07	15.18	7.57	68.35	6.83
10.80	4.22	16.99	4.90	57.26	5.83	4.72	19.06	5.50	64.20	6.52
8.00	3.03	14.94	4.27	63.71	6.05	3.29	16.25	4.64	69.25	6.57
11.27	5.07	16.50	10.55	52.34	4.27	5.71	18.59	11.89	59.00	4.81
7.72	19.41	22.12	6.97	37.76	6.02	21.02	23.98	7.55	40.93	6.52

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LITERATURE OF FUNGOUS DISEASES.*

By W. C. STURGIS, Mycologist.

A Provisional Bibliography of the more important works published by the U. S. Department of Agriculture and the Agricultural Experiment Stations of the United States from 1886 to 1893 inclusive, on Fungous and Bacterial Diseases of Economic Plants.

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The preparation of the following bibliography, already printed as Bulletin 118, has occupied what time and attention I have been able to spare from other duties during the past three years. Although meanwhile other publications have appeared covering the same ground, the present work has been prepared for publication in the hope that it might still prove of some value to intelligent farmers and horticulturists as well as to the mycologists of Experiment Stations.

General scope and plan of this Paper.—The determination of a fungus which is the cause of a specific disease of any economic plant is of course a matter for the specialist alone, but there seems to be no reason why any intelligent man should not be able to recognize, within certain limits, the cause of a diseased condition of a certain plant, provided only that he be furnished

* Including diseases caused primarily by Bacteria.

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with a list of all diseases to which that particular plant is liable, each disease being characterized by a common name more or less expressive of the effect which the agent of disease produces, or of some evident peculiarity of that agent whether vegetable or animal. It is solely with the fungous and bacterial parasites of economic plants that this bibliography has to do, and it has been thought advisable to give to the common names of the diseases recorded, a prominence which might serve to render the latter more readily recognizable.

Such recognition of a fungous disease being thus partially provided for, references are given to such publications as careful study has convinced me to be the best as regards the description and illustration of the cause or effect of the disease in question, and any line of treatment which has been tested. This will enable anyone who has access to agricultural libraries or to files of Station publications, to answer for himself many questions which at present he must refer to those who are better informed than himself.

As I have stated above, the ground of this Bulletin has already been covered, notably by certain publications of the Department of Agriculture,—the Experiment Station Record published monthly and giving digests of all publications of the Department and of the Stations; a Card Catalogue of the literature of the Experiment Stations and kindred institutions; and Bulletin 15 of the Office of Experiment Stations, a Handbook of Experiment Station Work consisting of a Popular Digest of the Publications of the Experiment Stations. It will be seen at once that these three sources of information have a very wide scope, an admirable feature in itself but one not altogether adapted to obviate the difficulties of reference which increase rapidly as the literature accumulates. It now frequently requires much labor to discover if a certain parasitic fungus of economic importance has been recorded in Station publications, if any definite line of treatment has been recommended, and if so, where and when. The consequence is that much work is likely to be repeated unnecessarily.

I have thought that by limiting the scope of this bibliography to diseases caused by fungi and bacteria alone, and broadly speaking, to the years 1886–1893, I might eliminate the danger of error incidental to a larger undertaking, and at the same time depend upon a careful and personal comparison of the available Station litera-

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ture under each subject to enable me to select what seemed to be the best.

Arrangement of topics.—The general arrangement of the work needs little comment. The main subjects are the host-plants and these are arranged alphabetically; under the name of each host-plant are arranged, also alphabetically, the "common names" of the fungous diseases recorded as affecting the plant. References to descriptions and illustrations either of the fungus itself or of its effect upon the host-plant follow, and finally a line of treatment, if any has been recommended or tested, is referred to. All references are arranged chronologically under each of the sub-headings,—*Description* and *Treatment.* The date of publication occupies the right-hand margin of the page. In the case of references to Annual Reports, the number of the Report is given, followed immediately by the year which it covers, and in the margin the date of publication for the sake of uniformity.

Occasionally I have referred to other than Station literature, viz., to Lamson-Scribner's "Fungous Diseases of the Grape and other Plants," and to "Garden and Forest." I have made these exceptions on the ground that both of these publications should be, and probably are, in every library of agriculture, and because the author of the former was for some time connected with the Department of Agriculture, and many of its best publications on economic mycology proceeded from him, while in the columns of Garden and Forest, there appear from time to time important notes upon fungous diseases by Station workers.

Wherever, as in the case of Black-Rot of Grapes or Scab of Apple, a great number of admirable papers have issued from many Stations, I have aimed first to select the fullest and best, and then to select those from widely separated localities in order that some one of the original publications referred to may be accessible to as many observers as possible. This has compelled me to omit many references which might have been recorded since I have thought it best not to record two of equal worth from adjacent States, in case it were possible to substitute for one of them, a publication from a widely different locality.

Common names of fungous diseases.—A word must be said regarding the so-called "common names" selected. Many names such as Black-Knot, Black-Rot, Rust, etc., have made such an impression that, as in the case of flowering plants, it would be unwise to disregard them. In economic mycology however, we

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are met by a difficulty regarding common names which is not so evident in the nomenclature of flowering plants. In the latter case the common names represent what alone the plants are known by either locally or nationally outside of scientific circles, and they have arisen spontaneously from common observation. In economic mycology on the other hand, many of the "common names" have been invented by the mycologists themselves and most loosely applied. Such, it is true, has not always been the case; thus every one recognizes that the "Rusts" belong to one group of fungi which the botanist calls *Uredineæ*, although doubtless the name first arose among people who were quite ignorant of the cause, but who noticed the rusty color produced uniformly by the disease; so in the case of the "Smuts," a common name fitly given by observant people, although the fungi causing "Smut," all happen to belong to the natural group of the *Ustilagineæ*. In such cases the common name has originated spontaneously and is fairly satisfactory. It is at least natural. But who knows even what one of the great natural groups of fungi is designated by the term "Leaf-Blight" or "Leaf-Spot," "Stem-Rot" or "Mildew?"

Where such confusion has necessarily arisen regarding common names given arbitrarily and with no definite plan or system, it is manifestly impossible to arrange them on any satisfactory lines, and it would be an impertinence for one observer to attempt all the desirable changes. Deeming it expedient for the reasons explained, to make use of common names in the present paper, and to give them a decided prominence, I have endeavored to group them as far as possible in conformity with the natural scientific arrangement, and in doing so, have ventured to change only a few which seem to have been originally bestowed with the least imaginable forethought. Such changes have been made chiefly in those diseases of the leaves which have been indiscriminately called "Leaf-Blight" or "Leaf-Spot." The former of these terms I have, with few exceptions, confined to conidial fungous forms belonging to the group of *Hyphomycetes* and producing upon the leaves attacked indeterminate or effused areas, which sometimes involve the whole leaf in a condition most aptly described by the term "Blight." The perithecial forms whether acigerous, pycinidial, or spermogonial, I have grouped together under the general term "Leaf-Spot," since the diseased areas produced by such forms in the leaf-tissue are often

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circumscribed in outline, giving the leaf a spotted appearance, and not infrequently become separated from the leaf altogether producing the appearance described as "shot-hole." That on this basis the same disease must at one time be called "Leaf-Blight" and later "Leaf-Spot," is very true, but it seems to be one of the lesser evils attending the use of common names. The term "Scab," I have limited to hyphomycetous fungi which produce upon either the leaves or fruit attacked determinate spots occupied by a dense growth of the fungus and more or less indurated, although here again I have thought it best to denominate as "Scab" certain fungi which may not produce any definite scabby appearance, but which nevertheless belong to genera such as *Fusicladium*, *Fusarium*, *Cladosporium* and the like, to which belong those fungi which were originally and aptly called "Scab-fungi." I have done this because it seems best to make these common names depend more upon scientific principles than upon some indefinite effect produced on the tissues of the host. Under the general term "Anthracnose," I have followed established precedent in including conidial forms belonging, with one exception, to the group of the *Melanconieæ*. That exception is the genus *Vermicularia* in which, though grouped with the *Sphaeropsideæ*, forms are included in which the perithecium is obsolete and which therefore approach the genus *Colletotrichum*. In cases where hyphomycetous fungi related to those which cause "Leaf-Blight," attack fruit and produce a decided decay, I have thought best to speak of them as "Fruit-Mould," and in some cases where similar effects are produced upon the leaves, as "Leaf-Mould," it being doubtful in some of these instances whether the attack is of a truly parasitic nature or does not more nearly resemble the process by which any dead organic substance becomes "mouldy."

Finally, I have followed established precedent in the use of common names wherever it seemed that the name so applied was one actually in common use, outside of scientific circles, to designate a specific disease of an economic plant. Such names I have not felt at liberty to change, although, upon a scientific basis, a change might appear both practicable and desirable. Such cases are the "White-Rust" (*Cystopus*) of the Beet, Cabbage, Radish and Turnip, the "Frenching" (*Fusarium*) of Cotton, the "Damping-off" (*Pythium*) of seedlings, "Plum-pockets" (*Taphrina*), "Leaf-curl" (*Exoascus*) of Peach, etc.

It will be noted that the familiarly descriptive term "Rot"

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has been applied to a great number of fungous diseases, a slight degree of system and clearness being secured by some qualifying prefix indicating where practicable, the portion attacked.

Nomenclature.—I have relied upon several sources for the scientific names which I have used. For the Phænogams I have followed Gray's Manual, and the Index Kewensis of Hooker and Jackson so far as that work has as yet appeared. For the fungi I have relied almost entirely upon Farlow & Seymour's Provisional Host-Index of the Fungi of the United States.

Abbreviations.—Little need be said regarding the abbreviations used, since most of them are readily intelligible. Among the publications referred to *Journ. Mycol.*, stands for the *Journal of Mycology*, at present issued serially by the Department of Agriculture, Division of Vegetable Pathology; *Scribner, Fung. Dis.*, refers to "*Fungous Diseases of the Grape and other Plants*," by F. Lamson Scribner, published by the J. T. Lovett Company, Little Silver, N. J., 1890; and *Gar. and For.* refers to the horticultural monthly "*Garden and Forest*," published from the Tribune building, New York City. The two latter publications are occasionally referred to for reasons stated above.

The names of States are abbreviated according to the usual custom; *Bulletin* and *Report* are abbreviated respectively to *Bull.* and *Rep.*, and, as already explained are arranged chronologically according to date of publication. Where two Stations exist in one State, they are distinguished by separate titles; thus *N. Y. Corn. Univ. Agr. Exp. Sta.*, refers to the Experiment Station connected with Cornell University at Ithaca, N. Y. The publications under the heading *U. S. Dept. Agr.*, and abbreviated to *Circ.* and *Farm. Bull.*, are occasional issues of the Department of Agriculture called *Circulars* and *Farmers Bulletins* which give information of value to farmers and others in a simple and concise form.

The abbreviations which precede the references will require more extended explanation. *Descr.*, indicates that in the work referred to, the fungus or its effect on the plant has been described; if followed by *Illus.*, the fungus or its effect has also been illustrated. *Occ.*, indicates that the occurrence of the fungus has been noted, with no further comment. *Treat.*, stands for Treatment, the abbreviation in parenthesis which follows being explanatory; (*rec.*), indicates that a definite line of treatment has been recommended, though based upon analogy and not

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upon any direct experiment; (*pos.*), that a positive line of treatment has been proved successful by definite experiments the results of which are recorded; (*neg.*), either that some treatment has been tried and has given negative results, or that nothing has yet been attempted in this direction. It may be well to note that *Cf*, the usual abbreviation of *Compare*, refers the reader to some other portion of the paper for further information.

In preparing this article for publication I am only too conscious that critical eyes will detect many errors and omissions. I have attempted to include only the best publications of permanent value relative to fungous diseases which have issued from the Department of Agriculture and the Agricultural Experiment Stations, between and including the years 1886 and 1893, though I have not always limited myself to those dates. Many will doubtless dissent from my judgment in the selection of papers as worthy of record; such critics I would ask kindly to inform me of any such errors or omissions in order that they may be corrected if possible and advisable.

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Alfalfa.

(*Medicago sativa*, L.)

Leaf-Spot (*Pseudopeziza Medicaginis*, (Lib.) Sacc.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 79–82. (1891)
Treat. (rec.), Del. Agr. Exp. Sta., Rep. 3, 1890, p. 82. (1891)
Root-Rot (*Ozonium auricomum*, Lk.)
Occ., Tex. Agr. Exp. Sta., Bull. 22. (1892)
Cf., Cotton (Root-Rot).

Almond.

(*Prunus* (*Amygdalus*) *communis*, L.)

Leaf-Blight (*Cercospora circumscissa*, Sacc.)
Descr. Illus., Journ. Mycol., Vol. vii, p. 66. (1892)
Treat. (pos.), Journ. Mycol., Vol. vii, p. 232. (1893)

Apple.

(*Pirus malus*, L.)

Black-Rot (*Sphaeropsis Malorum*, Berk.)
Descr., Scribner, Fung. Dis., p. 81. (1890)
Cf: Quince (Black-Rot).
Fire-Blight (*Micrococcus amylovorus*, Burrill.)
Descr., Colo. Agr. Exp. Sta., Rep. 1, 1888, pp. 64–69. (1888)
N. C. Agr. Exp. Sta., Bull. 92, p. 89. (1893)
Treat. (rec.), Colo. Agr. Exp. Sta., Rep. 1, 1888, pp. 69 & 70. (1888)
N. C. Agr. Exp. Sta., Bull. 92, p. 89. (1893)
Cf. Pear (Fire-Blight).
Fruit-Spot (*Phyllachora pomigena*, (Schw.) Sacc.)
Descr., Vt. Agr. Exp. Sta., Rep. 5, 1891, p. 133. (1892)
Leaf-Spot (*Phyllosticta pirina*, Sacc.)
Descr., Vt. Agr. Exp. Sta., Rep. 6, 1892, p. 83. (1893)
Va. Agr. Exp. Sta., Bull. 17, p. 62. (1892)
Treat. (rec.), Va. Agr. Exp. Sta., Bull. 17, p. 64. (1892)
Powdery-Mildew (*Podosphaera oxyacanthae*, (DC.), DBy.)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Circ. 8, p. 8. (1889)
Journ. Mycol., Vol. vi, p. 14. (1890)
U. S. Dep. Agr., Farm. Bull. 7, p. 14. (1892)
Cf. Journ. Mycol., Vol. vii, p. 256.
Ripe-Rot or Anthracnose (*Gloeosporium fructigenum*, Berk.; *G. versicolor*, B. & C.)
Descr. Illus., U. S. Dep. Agr. Rep. for 1887, p. 348. (1888)
Journ. Mycol., Vol. vi, p. 164. (1891)
Treat. (pos.), Journ. Mycol., Vol. vi, p. 172. (1891)
Ky. Agr. Exp. Sta., Bull. 44, p. 20. (1893)
Cf. Grape (Ripe-Rot).
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–333.

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Rust (*Gymnosporangium macropus*, Lk., Syn. *Roestelia pirata*, (Schw.) Thaxter).
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 370-378. (1889)
Scribner, Fung. Dis., p. 84. (1890)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1888, p. 379. (1889)
U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, p. 46. (1890)
Iowa Agr. Exp. Sta., Bull. 13, p. 43. (1891)
N. C. Agr. Exp. Sta., Bull. 92, p. 86. (1893)
Cf. Conn. Agr. Exp. Sta., Bull. 107.

Scab (*Fusicladium dendriticum*, (Wallr.) Fckl.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 341. (1888)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1887, p. 346. (1888)
U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, pp. 27 & 36. (1890)
U. S. Dep. Agr., Div. Veg. Path., Bull. 3, pp. 35 & 36. (1892)
Va. Agr. Exp. Sta., Bull. 17, p. 63. (1892)
N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 48, pp. 297 & 298. (1892)
N. C. Agr. Exp. Sta., Bull. 92, p. 87. (1893)
Conn. Agr. Exp. Sta., Bull. 115, pp. 3 & 4. (1893)

Barley.

(*Hordeum sp.*)

Ergot (*Claviceps purpurea*, Tul.)
See Rye (Ergot.)

Leaf-Blight (*Scolecotrichum graminis*, Fckl., and *Helminthosporium graminum*, Rab.)
Descr. and Illus., U. S. Dep. Agr., Rep. for 1886, p. 129. (1887)
Descr., Journ. Mycol., Vol. vii, pp. 96 & 97. (1892)

Rust (*Puccinia graminis*, P. and *P. Rubigo-vera*, (DC.) Wint.)
See Oats and Wheat (Rust).

Smut (*Ustilago Hordei*, (P.) Kell. & Sw., and *U. nuda*, (Jens.) Kell. & Sw.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 9, 1891, pp. 244-246. (1892)
Treat. (pos.), Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 246. (1892)
Cf. Oats and Wheat (Smut).

Bean.

(*Phaseolus vulgaris*, L.; *Faba vulgaris*, L., &c.)

Anthracnose (*Colletotrichum Lindemuthianum*, (Sacc. & Magn.) Bri. & Cav.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 361. (1888)
N. Y. Agr. Exp. Sta., Bull. 48, pp. 310 & 318. (1892)
Treat. (pos.), N. Y. Agr. Exp. Sta., Bull. 48, pp. 320-326. (1892)
U. S. Dep. Agr., Bot. Div., Bull. 8, p. 65. (1889)
N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 284. (1892)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326-333.

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Blight (Bacterial).
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 48, pp. 329–331. (1892)
N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 283. (1893)
Downy-Mildew (*Phytophthora Phaseoli*, Thaxter).
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 167–170. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 171. (1890)
Conn. Agr. Exp. Sta., Rep. 17, 1893, p. 77. (1894)
Leaf-Spot (*Phyllosticta* sp.)
Descr. N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 287. (1892)
Powdery Mildew (*Erysiphe Martii*, Lév.)
Treat. (pos.), Journ. Mycol., Vol. v, p. 214. (1889)
Rust (*Uromyces appendiculatus*, (P.) Lév.)
Descr. Illus., N. Y. Agr. Exp. Sta., Bull. 48, p. 331. (1892)
Treat. (neg.), N. Y. Agr. Exp. Sta., Bull. 48, p. 333. (1892)

Beet.

(*Beta vulgaris, L.*)

Blight (Bacterial).
Descr., Ind. Agr. Exp. Sta., Bull. 39, pp. 54–58. (1892)
Leaf-Blight (*Cercospora longissima*, C. and E.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, pp. 239–242. (1891)
Treat. (rec.), Iowa Agr. Exp. Sta., Bull. 15, p. 243. (1891)
Root-Rot (*Rhizoctonia Betae*, Kühn.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, pp. 244–248. (1891)
Treat. (rec.), Iowa Agr. Exp. Sta., Bull. 15, p. 250. (1891)
Rust (*Uromyces Betae*, (P.) Kühn).
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 351. (1888)
Descr., Iowa Agr. Exp. Sta., Bull. 15, p. 235. (1891)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 353. (1888)
Iowa Agr. Exp. Sta., Bull. 15, p. 236. (1891)
Scab (*Oospora scabies*, Thaxter.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, p. 251. (1891)
Ind. Agr. Exp. Sta., Bull. 39, p. 58. (1892)
Treat. (rec.), Ind. Agr. Exp. Sta., Bull. 39, p. 60. (1892)
Cf. Potato (Scab).
White-Rust (*Cystopus Bliti*, (Biv.) Lév.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 15, pp. 237 & 238. (1891)

Blackberry.

(*Rubus villosus*, Ait. *vars.*)

Anthracnose (*Glœosporium Venetum*, Speg.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 358–360. (1888)
Ohio Agr. Exp. Sta., Bull. Vol. iv, No. 6, p. 124. (1891)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1887, p. 361. (1887)
Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 172. (1890)
Ohio Agr. Exp. Sta., Bull. Vol. iv, No. 6, p. 119. (1891)

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Blight (Bacterial)
Occ., Ohio Agr. Exp. Sta., Bull. Vol. iv, No. 6, p. 129. (1891)
Cf. Raspberry (Blight.)
Leaf-Spot (*Septoria Rubi*, Westd.)
Descr., Ohio Agr. Exp. Sta., Bull. Vol. iv, No. 6, p. 126. (1891)
Treat. (neg.), Journ. Mycol., Vol. vii, p. 22. (1891)
(rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 129. (1893)
Rust (*Caeoma* (*Uredo*) *luminatum*, Lk.; Syn. *Puccinia Peckiana*, Howe.)
Descr., Ohio Agr. Exp. Sta., Bull. Vol. iv, No. 6, p. 127. (1891)
Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 224. (1891)
Descr. Illus., Ill. Agr. Exp. Sta., Bull. 29, pp. 273–281 & 286. (1893)
Treat. (pos.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 224. (1891)

Buckwheat.

(*Fagopyrum esculentum*, Mœnch.)

Leaf-Blight (*Ramularia rufomaculans*, Pk.)
Descr., Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)
Treat. (rec.), Conn. Agr. Ex. Sta., Rep. 14, 1890, p. 98. (1891)

Cabbage.

(*Brassica oleracea*, L.)

Club-Root (*Plasmodiophora Brassicæ*, Wor.)
Descr., N. J. Agr. Exp. Sta., Bull. 50, p. 14. (1888)
Descr. Illus., Journ. Mycol., Vol. vii, pp. 79–84. (1892)
N. J. Agr. Exp. Sta., Bull. 98. (1893)
Treat. (rec.), Journ. Mycol., Vol. vii, p. 85. (1892)
N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
N. J. Agr. Exp. Sta., Bull. 98, pp. 13–16. (1893)
Downy Mildew (*Peronospora parasitica*, (P.) Tul.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Leaf-Blight (*Macrosporium Brassicæ*, Berk.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
White Rust (*Cystopus candidus*, (P.) Lév.)
Occ., N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 84, p. 15. (1892)

Carnation.

(*Dianthus Caryophyllus*, L.)

Anthracnose (*Colletotrichum* sp.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 301. (1892)
Gar. and For., Vol. v, p. 594. (1892)
Treat. (rec.), Gar. and For., Vol. v, p. 595. (1892)
Anthracnose (*Vermicularia subeffigurata*, Schw.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 363. (1891)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 363. (1891)

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Leaf-Spot (*Septoria Dianthi*, Desm.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 363. (1891)
Gar. and For., Vol. v, p. 594. (1892)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 363. (1891)
Gar. and For., Vol. v, p. 594. (1892)
Rust (*Uromyces caryophyllinus*, (Schrank) Schrt.)
Descr. Illus., Gar. and For., Vol. v, pp. 18 & 19. (1892)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 302. (1892)
Treat. (rec.), Gar. and For., Vol. iv, p. 595. (1891)
Gar. and For., Vol. v, p. 19. (1892)
(pos.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 302. (1892)

Catalpa.

(*Catalpa Bignonioides*, Walt.)

Leaf-Blight (*Macrosporium Catalpae*, Ell. & Mart.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 364 & 365. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 366. (1888)
Leaf-Spot (*Phyllosticta Catalpae*, Ell. & Mart.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 364 & 365. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 366. (1888)

Celery.

(*Apium graveolens*, L.)

Blight (Bacterial).
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 257 & 258. (1892)
(?) Descr., N. Y. Agr. Exp. Sta., Bull. 51, pp. 134 & 136. (1893)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 258. (1892)
N. Y. Agr. Exp. Sta., Bull. 51, p. 136. (1893)
Leaf-Blight (*Cercospora Apii*, Fres.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 117–120. (1887)
N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 250. (1892)
Treat. (pos.), N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 251 & 252. (1892)
(pos.), Conn. Agr. Exp. Sta., Rep. 16, 1892, pp. 44 & 45. (1893)
Conn. Agr. Exp. Sta., Bull. 115, p. 17. (1893)
Leaf-Spot (*Phyllosticta Apii*, Halsted.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 253 & 254. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 254. (1892)
Leaf-Spot (*Septoria Petroselini*, Desm., *var. Apii*, Br. & Cav.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 255 & 256. (1892)
N. Y. Agr. Exp. Sta., Bull. 51, pp. 137 & 138. (1893)
Treat. (rec.), N. Y. Agr. Exp. Sta., Bull. 51, pp. 139–141. (1893)
Cf. Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 63–65.

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Rust (*Puccinia bullata*, (Pers.) Schrt.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 256 & 257. (1892)

Cherry.

(*Prunus Cerasus*, L.)

Black Knot (*Plowrightia morbosa*, (Schw.) Sacc.)
Descr. Illus., Scribner, Fung. Dis., p. 111. (1890)
Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 200. (1891)
N. J. Agr. Exp. Sta., Bull. 78. (1891)
N. Y. Agr. Exp. Sta., Bull. 40. (1892)
Treat. (rec.), N. Y. Agr. Exp. Sta., Bull. 40, p. 33. (1892)
Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 236–238. (1893)
Conn. Agr. Exp. Sta., Bull. 115, p. 9. (1893)

Fruit-Mould (*Oidium fructigenum*, Kze. & Schm.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, p. 349. (1889)
Ky. Agr. Exp. Sta., Rep. 2, 1889, pp. 31–34. (1890)
Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 213. (1891)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 352. (1889)
(pos.), Ky. Agr. Exp. Sta., Rep. 2, 1889, pp. 35–42. (1890)

Leaf-Spot (*Cylindrosporium Padi*, Karst.)
Descr. Illus., Scribner, Fung. Dis., p. 119. (1890)
Iowa Agr. Exp. Sta., Bull. 13, pp. 61–65. (1891)
Treat. (pos.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 176. (1890)
U. S. Dep. Agr., Rep. for 1890, p. 396. (1891)
Iowa Agr. Exp. Sta., Bull. 17, pp. 421–431. (1892)
(rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 114. (1893)
Cf. Plum. (Leaf-Spot).

Powdery Mildew (*Podosphaera oxyacanthæ*, (DC.) DBy.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 352–356. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 356. (1889)
(pos.), Iowa Agr. Exp. Sta., Bull. 17, pp. 422–428. (1892)
Cf. Apple (Powdery Mildew).

Rust (*Puccinia Pruni*, Pers.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 353 & 354. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 354. (1888)

Scab (*Cladosporium carpophilum*, Thüm.)
Occ., Iowa Agr. Exp. Sta., Bull. 17, p. 421. (1892)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 23, pp. 918–920. (1894)
Treat. (rec.), Iowa Agr. Exp. Sta., Bull. 23, pp. 920 & 921. (1894)
Cf. Peach and Plum (Scab).

Chestnut.

(*Castanea sativa*, Mill.)

Anthracnose (*Marsonia ochroleuca*, B. & C.)
Occ., Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 234. (1892)

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Chrysanthemum.

(*Chrysanthemum*, sp.)

Leaf-Spot (*Septoria* sp. and *Phyllosticta* sp.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 298. (1892)
Treat. (pos.), N. Y. Agr. Exp. Sta., "Leaf-Spot of Chrysanthemums." (1892)

Clematis.

(*Clematis* spp.)

Root-Rot (*Phoma* sp.)?
Descr., N. Y. Agr. Exp. Sta., Rep. 3, 1884, pp. 383 & 384. (1885)

Clover.

(*Trifolium* spp.)

Rust (*Uromyces Trifolii*, A. & S.) Wint.)
Descr. Illus., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 24. (1890)
Iowa Ag. Exp. Sta., Bull. 13, p. 58. (1891)
Treat. (rec.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 24, p. 139. (1890)
Stem-Rot (*Sclerotinia Trifolium*, Erick.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 84–88. (1891)
Treat. (neg.), Del. Agr. Exp. Sta., Rep. 3, 1890, p. 88. (1891)

Corn.

(*Zea Mays*, L.)

Blight (Bacterial.)
Descr. Illus., Ill. Agr. Exp. Sta., Bull. 6. (1889)
Treat. (neg.), Ill. Agr. Exp. Sta., Bull. 6, p. 174. (1889)
Leaf-Blight (*Helminthosporium graminum*, Rab.)
Occ., Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 171. (1890)
Rust (*Puccinia Maydis*, Bérang.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 390. (1888)
Treat. (neg.), U. S. Dep. Agr., Rep. for 1887, p. 391. (1888)
Smut (*Ustilago Maydis*, Cord.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 380–386. (1888)
Neb. Agr. Exp. Sta., Bull. 11, pp. 25–30. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, pp. 386 & 387. (1888)
Neb. Agr. Exp. Sta., Bull. 11, p. 35. (1889)
Ohio Agr. Exp. Sta., Bull., Vol. iii, No. 10, p. 271. (1890)

Cotton.

(*Gossypium* spp.)

Anthracnose (*Colletotrichum Gossypii*, Southworth.)
Descr. Illus., Journ. Mycol., Vol. vi, pp. 100–104 & 173–177. (1891)
Ala. Agr. Exp. Sta., Bull. 41, pp. 40–49. (1892)

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Blight (Bacterial.)
Descr., Ala. Agr. Exp. Sta., Bull. 27, p. 10. (1891)
"Frenching" or Scab (*Fusarium vasinfectum*, Atkinson.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 41, pp. 19–29. (1892)
Leaf-Blight (*Cercospora gossypina*, Cke.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 355 & 356. (1888)
Ala. Agr. Exp. Sta., Bull. 27, pp. 7 & 8. (1891)
Leaf-Mould (*Macrosporium nigricantium*, Atk. and *Alternaria* sp.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 27, pp. 8–10. (1891)
Leaf-Mould (*Ramularia areola*, Atkinson.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 41, pp. 55–58. (1892)
Leaf-Spot (*Sphaerella gossypina*, Atkinson.)
Descr. Illus., Ala. Agr. Exp. Sta., Bull. 41, pp. 58–60. (1892)
Root-Rot (*Ozonium auricomum*, Lk.)
Descr. Illus., Tex. Agr. Exp. Sta., Rep. 2, 1889, pp. 67–76. (1890)
Treat. (rec.), Tex. Agr. Exp. Sta., Rep. 2, 1889, p. 81. (1890)
Cf. Alfalfa (Root-Rot.)

Cranberry.

(*Vaccinium Oxycoccus*, L.)

Gall (*Synchytrium Vaccinii*, Thomas.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 64, pp. 4–9. (1889)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 64, p. 16. (1889)
N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 333. (1891)
"Scald" (Fungus Sp. indet.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 64, pp. 30–34. (1889)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 64, pp. 39 & 40. (1889)
Journ. Mycol., Vol. vi, p. 18. (1890)

Cucumber.

(*Cucumis sativus*, L.)

Anthracnose (*Glœosporium*, sp.)
Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 231. (1893)
Occ., Cf. Melon (Anthracnose.)
Blight (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 273–276. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 276. (1892)
Cf. Melon, Potato, Squash and Tomato (Blight).
"Damping-off" or Seedling-Mildew (*Pythium De Baryanum*, Hesse.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 220. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 221. (1891)
Downy Mildew (*Plasmopara Cubensis*, (B. & C.) Humphrey.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 8, 1890, pp. 210–212. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 227. (1893)

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Leaf-Blight (*Acremonium* sp.)
Descr., Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 227. (1892)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 230. (1893)
Powdery Mildew (*Erysiphe cichoracearum*, DC.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 225. (1893)
Treat. (pos.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 31, p. 188. (1891)
Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 225. (1892)
Scab (*Cladosporium cucumerinum*, Ell. & Arth.)
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 19, pp. 8–10. (1889)
Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 227–229. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 229. (1893)
Stem-Rot (*Sclerotinia Libertiana*, Fckl.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 212–224. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 222. (1893)

Currant.

(*Ribes*, spp.)

Anthracnose (*Glœosporium Ribis*, (Lib.) Mont. & Desm.)
Descr. Illus., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 15, p. 196. (1889)
Treat. (rec.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 15, p. 197. (1889)
Leaf-Spot (*Septoria Ribis*, Desm., and *Cercospora angulata*, Wint.)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 13, pp. 68 & 69. (1891)
Treat. (pos.), Iowa Agr. Exp. Sta., Bull. 17, pp. 420 & 421. (1892)
Powdery Mildew (*Sphaerotheca mors-uvae* (Schw.) B. & C.)
See Gooseberry (Powdery Mildew.)

Egg-plant.

(*Solanum Melongena*, L.)

Anthracnose (*Glœosporium melongenae*, Ell. & Hals.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 281. (1892)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–333.
"Damping-off," or Seedling-Mildew (*Pythium DeBaryanum*, Hesse.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 286. (1893)
Cf. Cucumber (Damping-off.)
Fruit-Mould (*Botrytis fasciculars*, (Cord.) Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 357. (1891)
Leaf-Spot (*Phyllosticta hortorum*, Speg.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 11, 1890, pp. 355–357. (1891)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 357. (1891)

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Seedling-Rot (*Phoma Solani*, Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 277–279. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 279. (1892)
Stem-Rot (*Nectria Ipomœae*, Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 281–283. (1892)

Fig.

(*Ficus Carica*, L.)

Rust (*Uredo Fici*, Cast.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)
Scab (*Fusarium roseum*, Lk.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 117. (1893)

Filbert.

(*Corylus Avellana*, L.)

Black Knot (*Cryptosporella anomala*, (Pk.) Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 287. (1893)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 289. (1893)
Cf. Hazel (Black Knot.)

Geranium.

(*Pelargonium sp.*)

Rot (Bacterial.)
Descr. Illus., Journ. Mycol., Vol. vi, p. 114. (1891)

Gooseberry.

(*Ribes Grossularia*, L.)

Leaf-Spot (*Septoria Ribis*, Desm., and *Cercospora angulata*, Wint.)
Cf. Currant (Leaf-Spot.)
Leaf-Spot (? *Sphaerella Grossulariae*, (Fr.) Awd.)
Iowa Agr. Exp. Sta., Bull. 13, p. 70. (1891)
Powdery Mildew (*Sphaerotheca mors-uvae*, (Schw.) B. & C.
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 373–378. (1888)
Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 240. (1893)
Descr., N. C. Agr. Exp. Sta., Bull. 92, p. 131. (1893)
Treat. (pos.), N. Y. Agr. Exp. Sta., Rep. 6, 1887, p. 349. (1888)
N. Y. Agr. Exp. Sta., Bull. 36, p. 645. (1891)
N. C. Agr. Exp. Sta., Bull. 92, p. 131. (1893)
Rust (*Aecidium Grossulariae*, Schum.)
Descr., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 241. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 241. (1893)

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Grape.

(*Vitis spp.*)

Anthracnose (*Sphaceloma ampelinum*, DBy.)
Descr. Illus., Scribner, Fung. Dis., pp. 72–80. (1890)
Tenn. Agr. Exp. Sta., Bull. Vol. iv, No. 4, pp. 111 & 112. (1891)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 9, 1890, pp. 336 & 337. (1891)
Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 102. (1891)
Tenn. Agr. Exp. Sta., Bull. Vol. iv, No. 4, p. 112. (1891)
N. C. Agr. Exp. Sta., Bull. 92, p. 121. (1893)

Bitter-Rot (*Melanconium fuligineum*, (Scrib. & Viala.) Cav.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 324 & 325. (1888)
Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, p. 325. (1891)
Treat. (neg.), U. S. Dep. Agr., Rep. for 1887, p. 325. (1888)
(rec.), Scribner, Fung. Dis., p. 40. (1890)
Cf. N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 61, pp. 302–305.

Black-Rot (*Laestadia Bidwellii*, (Ell.) Viala & Ravaz.
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 109–111. (1887)
Del. Agr. Exp. Sta., Bull. 6, pp. 18–27. (1889)
Scribner, Fung. Dis., pp. 8–14. (1890)
Tenn. Agr. Exp. Sta., Bull. Vol. iv, No. 4, pp. 98–101. (1891)
Treat (pos.), U. S. Dep. Agr., Sec. Veg. Path., Circ. 6. (1889)
U. S. Dep. Agr., Farm. Bull. 7, pp. 15 & 16. (1892)
Del. Agr. Exp. Sta., Bull. 15, p. 7. (1892)
U. S. Dep. Agr., Div. Veg. Path., Bull. 3, p. 31. (1892)
Tex. Agr. Exp. Sta., Bull. 23, pp. 228–231. (1892)
Conn. Agr. Exp. Sta., Bull. 115, p. 11. (1893)

Downey Mildew (*Plasmopara viticola*, (B. & C.) Berl. & De Ton.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 96–99. (1887)
Tenn. Agr. Exp. Sta., Bull. Vol. iv, No. 4, p. 108. (1891)
Mich. Agr. Exp. Sta., Bull. 83, pp. 9–12. (1892)
Treat. (pos.), Ohio Agr. Exp. Sta., Bull. Vol. iii, No. 10, p. 263. (1890)
U. S. Dep. Agr., Farm. Bull. 4, p. 8. (1891)
Tenn. Agr. Exp. Sta., Bull. Vol. iv, No. 4, p. 110. (1891)
Conn. Agr. Exp. Sta., Bull. 115, p. 12. (1893)

Leaf-Blight (*Cercospora viticola*, (Ces.) Sacc.)
Descr. Illus., Scribner, Fung. Dis. pp. 60–62. (1890)
Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, p. 324. (1891)
Treat. (neg.), N. Y. Agr. Exp. Sta., Rep. 9, 1890, p. 324. (1891)
(rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 122. (1893)

Powdery Mildew (*Uncinula spiralis*, B. & C.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1886, pp. 105–108. (1887)
Mich. Agr. Exp. Sta., Bull. 83, p. 11. (1892)

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Powdery Mildew (*Uncinula spiralis*, B. & C.)
Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, pp. 322 & 323. (1891)
Treat. (pos.), U. S. Dep. Agr., Farm. Bull. 4, p. 8. (1891)
Ind. Agr. Exp. Sta., Bull. 38, p. 17. (1892)
N. C. Agr. Exp. Sta., Bull. 92, p. 120. (1893)
Ripe-Rot or Anthracnose (*Glœosporium fructigenum*, Berk.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1890, p. 408. (1891)
Journ. Mycol., Vol. vi, pp. 164–171. (1891)
Cf. Apple (Ripe-Rot.)
Root-Rot (*Armillaria mellea*, (Wallr.) Fr. and *Dematophora necatrix*, Hartig.)
Descr. Illus., Scribner, Fung. Dis., pp. 64–69. (1890)
N. C. Agr. Exp. Sta., Bull. 92, p. 122. (1893)
Treat. (rec.), Scribner, Fung. Dis., pp. 70 & 71. (1890)
N. C. Agr. Exp. Sta., Bull. 92, p. 122. (1893)
White-Rot (*Coniothyrium Diplodiella*, (Speg.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 325 & 326. (1888)
Scribner, Fung. Dis., pp. 41–44. (1890)
Descr., N. Y. Agr. Exp. Sta., Rep. 9, 1890, p. 324. (1891)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Bull. 11. (1890)

Hazel.

(*Corylus*, spp.)

Black-Knot (*Cryptosporella anomala*, (Pk.) Sacc.)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 242. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 243. (1893)
Cf. Filbert (Black-Knot).

Hollyhock.

(*Althaea rosea*, Cav.)

Anthracnose (*Colletotrichum Malvarum*, (Braun. & Casp.) Southworth.)
Descr. Illus., Journ. Mycol., Vol. vi, pp. 46–48. (1890)
Treat. (pos.), Journ. Mycol., Vol. vi, p. 50. (1890)
N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Leaf-Blight (*Cercospora Althaeina*, Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 361. (1891)
Cf. Garden and Forest, March 26, 1890.
Leaf-Spot (*Phyllosticta Althaeina*, Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 297. (1892)
Rust (*Puccinia Malvacearum*, Mont.)
Descr. Illus., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 25, p. 154. (1890)
Treat. (rec.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 25, p. 155. (1890)
Cf. N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 361.

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Horseradish.

(*Cochlearia Armoracia*, L.)

Leaf-Blight (*Ramularia Armoraciæ*, Fckl.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 360. (1891)
Leaf-Spot (*Septoria Armoraciæ*, Sacc.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 360. (1891)

Hydrangea.

(*Hydrangea Hortensia*, Siebold.)

Leaf-Spot (*Phyllosticta Hydrangeæ*, Ell. & Ev.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 298. (1892)
Cf. Garden and Forest, Vol. iv, p. 177, 1891.

Lettuce.

(*Lactuca sativa*, L.)

Downy Mildew (*Bremia Lactucæ*, Regel.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 4, 1885, p. 253. (1886)
Treat. (pos.), Journ. Mycol., Vol. vi, p. 17. (1890)
Mass. (Hatch) Agr. Exp. Sta., Bull. 4, pp. 11–14. (1889)
Vt. Agr. Exp. Sta., Rep. 5, 1891, p. 141. (1892)
Leaf-Rot (*Botrytis vulgaris*, Fr.)
Descr., Mass. Agr. Exp. Sta., Rep. 9, 1891, pp. 219–221. (1892)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 221. (1892)
Leaf-Spot (*Septoria consimilis*, Ell. & Mart.)
Descr. Illus., Ohio Agr. Exp. Sta., Bull. 44, pp. 145 & 146. (1892)
Stem-Rot (Bacterial.)
Descr., Vt. Agr. Exp. Sta., Rep. 6, 1892, p. 87. (1893)
Treat. (rec.), Vt. Agr. Exp. Sta., Rep. 6, 1892, p. 88. (1893)

Maple.

(*Acer*, spp.)

Leaf-spot (*Phyllosticta acericola*, Cke. & Ell.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 383–386. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 386. (1889)

Melon.

(*Cucumis*, spp.)

Anthracnose (*Colletotrichum lagenarium*, (Pass.) Ell. & Hals.)
Descr., U. S. Dep. Agr., Bot. Div., Bull. 8, p. 64. (1889)
Treat. (pos.), Md. Agr. Exp. Sta., Rep. 4, 1891, p. 387. (1892)
Blight (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 273 & 274. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 276. (1892)
Cf. Cucumber, Potato, Squash and Tomato (Blight.)
Downy Mildew (*Plasmopara Cubensis*, (B. & C.) Humphrey.)
See Cucumber (Downy Mildew.)

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Mignonette.

(*Reseda odorata*, L.)

Leaf-Blight (*Cercospora Resedæ*, Fckl.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1889, pp. 429 & 430. (1890)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1889, p. 431. (1890)

Nasturtium.

(*Tropæolum Majus*, L.)

Leaf-Blight *Alternaria*, sp., and *Pleospora Tropæoli*, Hals.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 290–293. (1893)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 299. (1892)

Oats.

(*Avena sativa*, L.)

Blight (Bacterial.)
Descr., Journ. Mycol., Vol. vi, p. 72. (1890)
Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 225. (1891)

Rust (*Puccinia coronata*, Cda., *P. graminis*, P., and *P. Rubigo-vera*, (DC.) Wint.)
Descr. Illus., Kan. Agr. Exp. Sta., Bull. 38. (1893)
Treat. (neg.), Journ. Mycol., Vol. vii, pp. 225 & 226. (1893)
Cf. Wheat (Rust.)

Smut (*Ustilago Avenæ*, (P.) Jensen.)
Descr. Illus., Kans. Agr. Exp. Sta., Bull. 8. (1889)
N. Dak. Agr. Exp. Sta., Bull. 1. 1891)
U. S. Dep. Agr., Div. Veg. Path., Farm. Bull. 5. (1892)
R. I. Agr. Exp. Sta., Bull. 15. (1892)
Treat. (pos.), Kan. Agr. Exp. Sta., Bull. 15, pp. 128–130. (1890)
N. Dak. Agr. Exp. Sta., Bull. 1, pp. 25–28. (1891)
U. S. Dep. Agr., Div. Veg. Path., Farm. Bull. 5. (1892)
R. I. Agr. Exp. Sta., Bull. 15, pp. 6–8. (1892)

Olive.

(*Olea Europæa*, L.)

Tuberculosis (Bacterial.)
Descr. Illus., Journ. Mycol., Vol. vi, pp. 148–153. (1891)

Onion.

(*Allium Cepa*, L.)

Anthracnose or Rot (*Vermicularia circinans*, Berk.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 163. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 164 & 165. (1890)

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"Damping-off" or Seedling-Mildew (*Pythium De Baryanum*, Hesse.)
Occ., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 165 & 166. (1890)
Cf. Cucumber ("Damping-off.")
Downy Mildew (*Peronospora Schleideniana*, DBy.)
Descr. Illus., Wis. Agr. Exp. Sta., Rep. 1, 1883, pp. 38–44. (1884)
N. Y. Corn. Univ. Exp. Sta., Rep. 2, 1889, pp. 193 & 194. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 157. (1890)
Smut (*Urocystis Cepulae, Frost.*)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 129–146. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rept. 13, 1889, pp. 147–153. (1890)
(Transplanting), Conn. Agr. Exp. Sta., Bull. 115, p. 15. (1893)
Cf. Ohio Agr. Exp. Sta., Bull. Vol. iii, No. 9, p. 244.
Tenn. Agr. Exp. Sta., Bull. Vol. v, No. 4, p. 147.
Stalk-Blight (*Macrosporium Sarcinula*, B. *var. parasiticum*, Thm., and *M. Porri*, Ell.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 13, 1889, pp. 158–162. (1890)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 13, 1889, p. 161. (1890)

Orange.

(*Citrus Aurantium*, L.)

Anthracnose (*Colletotrichum adustum*, Ell.)
Occ., Journ. Mycol., Vol. vii, p. 34. (1891)
Leaf-glaze (*Strigula complanata*, Fée.)
Occ., Journ. Mycol., Vol. vii, p. 36. (1891)
Leaf-Mould (*Caprodium Citri*, Berk. & Desm.)
Occ., Journ. Mycol., Vol. vii, p. 35. (1891)
Treat. (rec.), Journ. Mycol., Vol. vii, p. 35. (1891)
(Cf. Bull. Bussey Inst. I, pp. 404–414.)
Scab (*Cladosporium sp.*)
Descr., Fla. Agr. Exp. Sta., Bull. 2, pp. 35 & 36. (1888)
Journ. Mycol., Vol. vii., p. 34. (1891)
Treat. (rec.), Fla. Agr. Exp. Sta., Bull. 2, p. 37. (1888)
Journ. Mycol., Vol. vii, p. 34. (1891)

Orchid.

(*Orchidaceæ.*)

Anthracnose (*Glœosporium sp.*)
Occ., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 298. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 298. (1892)

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Pea.

(*Pisum sativum*, L.)

Powdery Mildew (*Erysiphe Martii*, Lév.)
Occ., S. Dak. Agr. Exp. Sta., Bull. 29, p. 39. (1891)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 4, 1885, p. 187. (1886)
Cf. Bean (Powdery Mildew.)

Peach.

(*Prunus Persica*, Benth. & Hook.)

Anthracnose (*Glœosporium laeticolor*, Berk.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 325. (1893)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 328.
Fruit-Mould (*Oidium fructigenum*, Kze. & Schm.)
Descr. Illus., Journ. Mycol., Vol. vii, pp. 36–38. (1891)
Treat. (pos.), Del. Agr. Exp. Sta., Bull. 19, pp. 15 & 16. (1892)
Del. Agr. Exp. Sta., Rep. 5, 1892, p. 66. (1893)
(rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 102. (1893)
Cf. Cherry (Fruit-Mould.)
Leaf-Blight (*Cercospora Persica*, Sacc.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1893)
Leaf-Blight (*Cercosporella Persica*, Sacc.)
Occ., Journ. Mycol., Vol. vii, p. 91. (1892)
Leaf-Curl (*Exoascus deformans*, (Berk.) Fckl.)
Descr. Illus., Scribner, Fung. Dis., pp. 127–130. (1890)
N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 103. (1893)
Powdery Mildew (*Sphaerotheca pannosa*, (Wallr.) Lév. (?)
Occ., Journ. Mycol., Vol. vii, p. 90. (1892)
Rust (*Puccinia Pruni*, P.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 353 & 354. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 355. (1888)
Scab (*Cladosporium carpophilum*, Thüm.)
Descr. Illus., Ind. Agr. Exp. Sta., Bull. 19, pp. 5–8. (1889)
Treat. (rec.), Ind. Agr. Exp. Sta., Bull. 19, p. 8. (1889)

Pear.

(*Pirus Communis*, L.)

Dry-Rot (*Thelephora pedicellata*, Schw.)
Descr., Journ. Mycol., Vol. vi, pp. 113 & 114. (1891)
Treat. (pos.), Journ. Mycol., Vol. vi, p. 114. (1891)
Fire-Blight (*Micrococcus amylovorus*, Burrill.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 275–289. (1887)
Descr., Ala. Agr. Exp. Sta., Bull. 50. (1893)

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Fire-Blight (*Micrococcus amylovorus*, Burrill.)
Treat. (rec.), Ill. Agr. Exp. Sta., Bull. 2, pp. 16 & 17. (1886)
(neg.), Mo. Agr. Exp. Sta., Bull. 16, pp. 8 & 9. (1891)
(rec.), Mich. Agr. Exp. Sta., Bull. 83, p. 14. (1892)
Cf. N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 300–315.
Cf. Apple (Fire-Blight.)
Leaf-Spot (*Entomosporium maculatum*, Lév.).
Descr. Illus., U. S. Dep. Agr., Report for 1888, pp. 359–362. (1889)
Scribner, Fung. Dis., pp. 101–104. (1890)
Del. Agr. Exp. Sta., Bull. 13, pp. 4–6. (1891)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Circ. 8, p. 6. (1889)
Del. Agr. Exp. Sta., Bull. 15, pp. 9 & 10. (1892)
U. S. Dep. Agr., Farm. Bull. 7, p. 15. (1892)
Conn. Agr. Exp. Sta., Bull. 115, pp. 4 & 5. (1893)
Cf. Quince (Leaf-Spot.)
Rust (*Gymnosporangium globosum*, Farl.)
Occ., Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)
Treat. (rec.), Conn. Agr. Exp. Sta., Rep. 14, 1890, p. 98. (1891)
Scab (*Fusicladium pirinum*, (Lib.) Fckl.)
Descr. Illus., Scribner, Fung. Dis., pp. 98 & 99. (1890)
N. Y. Agr. Exp. Sta., Bull. 67, pp. 191 & 192. (1894)
Treat. (pos.), Del. Agr. Exp. Sta., Bull. 8, pp. 11–14. (1890)
U. S. Dep. Agr., Farm. Bull. 7, p. 15. (1892)
Del. Agr. Exp. Sta., Bull. 28, pp. 30–34. (1892)
Conn. Agr. Exp. Sta., Bull. 115, p. 5. (1893)
N. Y. Agr. Exp. Sta., Bull. 67. (1894)
Cf. Apple (Scab.)

Peppers.

(*Capsicum annuum*, L.)

Anthracnose (*Colletotrichum nigrum*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 359. (1891)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 360. (1891)
Cf. N. J. Agr. Exp. Sta., Rep. 13, pp. 332 & 333. (1893)
Anthracnose (*Glœosporium piperatum*, Ell. & Ev.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 358. (1891)
Treat. (rec.), N. J. Agr. Sta., Rep. 11, 1890, p. 360. (1891)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 330 & 331. (1893)

Persimmon.

(*Diospyros*, spp.)

Anthracnose (*Glœosporium*, sp.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–330.
Cf. Apple (Ripe-Rot or Anthracnose.)

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Leaf-Blight (*Cercospora* sp.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Cf. Peach (Leaf-Blight.)
Root-Rot (*Armillaria mellea*, (Wallr.) Fr.)
Occ., N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 116. (1893)
Cf. Grape (Root-Rot.)

Pink (Sweet William.)

(*Dianthus barbatus*, L.)

Rust (*Puccinia Arenariæ*, (Schum.) Wint.)
Descr. Illus., N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 278–280. (1893)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 280. (1893)

Plum.

(*Prunus* spp.)

Black Knot (*Plowrightia morbosa*, (Schw.) Sacc.)
See Cherry (Black Knot.)
Fruit-Mould (*Oidium fructigenum*, Kze. & Schm.)
See Cherry (Fruit-Mould.)
Leaf-Spot (*Cylindrosporium Padi*, Karst.)
Descr. Illus., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 293-296. (1887)
Iowa Agr. Exp. Sta., Bull. 13, pp. 55–65. (1891)
Treat. (pos.), Ohio Agr. Exp. Sta., Bull., Vol. iv, No. 9, p. 216. (1891)
Journ. Mycol., Vol. vii, p. 255. (1893)
Cf. Cherry (Leaf-Spot.)
Plum-Pockets (*Taphrina Pruni*, (Fckl.) Tul.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 366–369. (1889)
Occ. Illus., Mich. Agr. Exp. Sta., Bull. 83, pp. 18 & 19. (1892)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 92, p. 111. (1893)
Powdery Mildew (*Podosphæra Oxyacanthæ*, (DC.) DBy.)
See Cherry (Powdery Mildew.)
Rust (*Puccinia Pruni*, Pers.)
See Cherry (Rust.)
Scab (*Cladosporium carpophilum*, Thüm.)
Descr., Journ. Mycol., Vol. vii, pp. 99 & 100. (1892)
Descr. Illus., Iowa Agr. Exp. Sta., Bull. 23, pp. 918–920. (1894)
Cf. Cherry and Peach (Scab.)

Poplar.

(*Populus* spp.)

Rust (*Melampsora populina*, (Jacq.) Lév.)
Occ. Treat., Mass. Agr. Exp. Sta., Rep. 9, 1891, pp. 233 & 234. (1892)

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Potato.

(*Solanum tuberosum*, L.)

Blight (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 269. (1892)
Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 54–56. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 12, 1891, p. 276. (1892)
Del. Agr. Exp. Sta., Bull. 15, p. 13. (1892)
Cf. Cucumber, Melon, Squash and Tomato (Blight.)

Downy Mildew or Rot (*Phytophthora infestans*, DBy.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 337 & 338. (1889)
Me. Agr. Exp. Sta., Rep., 1889, pp. 172–178. (1890)
Treat. (pos.), Ohio Agr. Exp. Sta., Bull., Vol. ii, No. 6, pp. 162–169. (1889)
U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, pp. 47 & 48. (1890)
R. I. Agr. Exp. Sta., Bull. 14, pp. 186 & 187. (1891)
Vt. Agr. Exp. Sta., Rep. 6, 1892, pp. 57–66. (1893)
Conn. Agr. Exp. Sta., Bull. 115, pp. 15 & 16. (1893)

Leaf-Blight (*Macrosporium Solani*, Ell. & Mart.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 58 & 59. (1892)
Vt. Agr. Exp. Sta., Bull. 36. (1893)
Treat. (pos.), Del. Agr. Exp. Sta., Rep. 4, 1891, p. 60. (1892)
Vt. Agr. Exp. Sta., Bull. 36. (1893)

Scab (*Oospora scabies*, Thaxter.)
Descr. Illus., Conn. Agr. Exp. Sta., Rep. 14, 1890, pp. 81–95. (1891)
N. Dak. Agr. Exp. Sta., Bull. 4, pp. 6 & 7. (1891)
Treat. (pos.), N. Dak. Agr. Sta. Exp., Bull. 9, pp. 31–33. (1893)
R. I. Agr. Exp. Sta., Bull. 26, p. 155. (1893)
Wash. Agr. Exp. Sta., Bull. 8, pp. 137 & 138. (1894)
(Cf. Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 153–160.)
Cf. Beet (Scab.)

Privet.

(*Ligustrum vulgare*, L.)

Anthracnose (*Glœosporium cingulatum*, Atkinson.)
Descr. Illus., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 49, pp. 306–314. (1892)

Quince.

(*Pirus Cydonia.*)

Black-Rot (*Sphæropsis Malorum*, Berk.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 91, pp. 8–10. (1892)
Treat. (rec.), Conn. Agr. Exp. Sta., Bull. 115, pp. 6 & 7. (1893)
Cf. Apple (Black-Rot.)

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Fire-Blight (*Micrococcus amylovorus*, Burrill.)
See Apple and Pear (Fire-Blight.)
Leaf-Spot (*Entomosporium maculatum*, Lév.)
Descr. Illus., See Pear (Leaf-Spot.)
Treat. (pos.), U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, pp. 46 & 47. (1890)
Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 150–152. (1892)
Conn. Agr. Exp. Sta., Bull. 115, p. 6. (1893)
Cf. Pear (Leaf-Spot.)
Pale-Rot (*Phoma Cydoniæ*, Sacc. & Schulz.) ?
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 91, pp. 10 & 11. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 91, p. 11. (1892)
Ripe-Rot or Anthracnose (*Glœosporium fructigenum*, Berk.)
See Apple and Grape (Ripe-Rot.)

Radish.

(*Raphanus sativus*, L.)

Club-Root (*Plasmodiophora Brassicæ*, Wor.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, pp. 348 & 349. (1891)
Cf. Cabbage (Club-Root.)
Downy Mildew (*Peronospora parasitica*, (P.) Tul.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 349. (1891)
Cf. Turnip (Downy Mildew.)
White Rust (*Cystopus candidus*, (P.) Lév.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 350. (1891)
Treat. (rec.), N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 350. (1891)
Cf. Turnip (White Rust.)

Raspberry.

(*Rubus* spp.)

Anthracnose (*Glœosporium Venetum*, Speg.)
See Blackberry (Anthracnose.)
Blight (Bacterial.)
Descr., Ohio Agr. Exp. Sta., Bull., Vol. iv, No. 6, p. 128. (1891)
Leaf-Spot (*Septoria Rubi*, Westd.)
See Blackberry (Leaf-Spot.)
Rust (*Cæoma* (*Uredo*) *luminatum*, Lk.)
See Blackberry (Rust.)

Rose.

(*Rosa* spp.)

Anthracnose (*Glœosporium Rosæ*, Hals.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 282 & 283. (1893)
Downy Mildew (*Peronospora sparsa*, Berk.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 282. (1893)

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Leaf-Spot (*Actinonema Rosæ*, (Lib.) Fr.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 366–368. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, pp. 368 & 369. (1888)
(pos.), Mass. (Hatch) Agr. Exp. Sta., Bull. 4, pp. 10 & 11. (1889)
N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 281. (1893)
Powdery Mildew (*Sphærotheca pannosa*, (Wallr.) Lév.)
Descr., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 281. (1893)
Treat. (pos.), Mass. (Hatch) Agr. Exp. Sta., Bull. 4, p. 11. (1889)
N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 281 & 282. (1893)
Rust (*Phragmidium speciosum*, Fr.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, p. 372. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 372. (1888)
Rust (*Phragmidium subcorticium*, (Schrank) Wint.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 369 & 370. (1888)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1887, p. 371. (1888)
N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 282. (1893)

Rye.

(*Secale cereale*, L.)

Ergot (*Claviceps purpurea*, Tul.)
Descr. Illus., S. Dak. Exp. Sta., Bull. 33, pp. 40–43. (1893)
Treat. (rec.), N. C. Agr. Exp. Sta., Bull. 76, p. 20. (1891)
S. Dak. Agr. Exp. Sta., Bull. 33, pp. 43 & 44. (1893)
Rust (*Puccinia graminis*, P., and *P. Rubigo-vera*, (DC.) Wint.)
See Oats and Wheat (Rust.)
Smut (*Urocystis occulta*, (Wallr.) Rabh.)
Occ. Illus., Mass. Agr. Exp. Sta., Rep. 9, 1891, p. 247. (1892)
Treat. (pos.), See Oats and Wheat (Smut.)

Salsify.

(*Tragopogon porrifolius*, L.)

Rot (Bacterial.)
Descr., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 351. (1891)

Sorghum.

(*Sorghum vulgare*, P.)

Blight (*Bacillus Sorghi*, Burrill.)
Descr., Kan. Agr. Exp. Sta., Rep. 1, 1888, pp. 281–301. (1889)
Treat. (rec.), Kan. Agr. Exp. Sta., Rep. 1, 1888, pp. 301 & 302. (1889)
Smut (*Ustilago Sorghi*, (Lk.) Pass., and *U. Reiliana*, Kühn.)
Descr. Illus., Kan. Agr. Exp. Sta., Bull. 23, pp. 95 & 96. (1891)
Treat. (neg.), Kan. Agr. Exp. Sta., Bull. 23, p. 101. (1891)

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Spinach.

(*Spinacia oleracea*, Mill.)

Anthracnose (*Colletotrichum Spinaceæ*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70, pp. 6–8. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13 & 14. (1890)
Downy Mildew (*Peronospora effusa*. (Grev.) Rabh.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70, pp. 4–6. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13 & 14. (1890)
Mass. Agr. Exp. Sta., Rep. 8, 1890, pp. 221 & 222. (1891)
Leaf-Spot (*Phyllosticta Chenopodii*, Sacc.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70, pp. 9 & 10. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13 & 14. (1890)
Scab (*Cladosporium macrocarpum*, Preuss.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70, pp. 11 & 12. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13 & 14. (1890)
White Smut (*Entyloma Ellisii*, Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 70, pp. 10 & 11. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 70, pp. 13 & 14. (1890)

Squash.

(*Cucurbita* spp.)

Anthracnose (*Colletotrichum lagenarium*, (Pass.) Ell. & Hals.)
See Melon (Anthracnose.)
Blight (Bacterial.)
See N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 274–276. (1892)
Cf. Cucumber, Melon, Potato and Tomato (Blight.)
Downy Mildew (*Plasmopara Cubensis*, (B. & C.) Humphrey.)
See Cucumber (Downy Mildew.)
Powdery Mildew (*Erysiphe cichoracearum*, DC.)
Descr. Illus., See Cucumber (Powdery Mildew.)
Treat. (pos.), Corn. Univ. Agr. Exp. Sta., Bull. 35, pp. 330–332. (1891)
Cf. Cucumber (Powdery Mildew.)

Strawberry.

(*Fragaria* spp.)

Leaf-Spot (*Ascochyta Fragariæ*, Sacc.)
Descr. Illus., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 14, pp. 182 & 183. (1889)
Treat. (rec.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 14, p. 183. (1889)
Leaf-Spot (*Sphærella Fragariæ*, (Tul.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1887, pp. 334–339. (1888)
N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 14, pp. 171–181. (1889)

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Leaf-Spot (*Sphærella Fragariæ*, (Tul.) Sacc.)
Treat. (pos.), U. S. Dep. Agr., Rep. for 1890, p. 397. (1890)
Ken. Agr. Exp. Sta., Bull. 31, pp. 7–12. (1890)
Md. Agr. Exp. Sta., Rep. 3, 1890, pp. 106–108. (1891)
N. C. Agr. Exp. Sta., Bull. 92, p. 133. (1893)
Conn. Agr. Exp. Sta., Bull. 115, p. 14. (1893)
Powdery Mildew (*Sphærotheca Castagnei*, Lév.)
Descr., N. Y. Agr. Exp. Sta., Rep. 5, 1886, pp. 291 & 292. (1887)
Descr. Illus., Mass. Agr. Exp. Sta., Rep. 10, 1892, p. 239. (1893)
Treat. (rec.), N. Y. Agr. Exp. Sta., Rep. 5, 1886, p. 293. (1887)
Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 243–245. (1893)

Sweet Potato.

(*Ipomœa Batatas*, Lam.)

Black-Rot (*Ceratocystis fimbriata*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 7–13. (1890)
Journ. Mycol., Vol. vii, pp. 1–9. (1891)
U. S. Dep. Agr., Rep. for 1891, pp. 376 & 377. (1892)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 76, pp. 13 & 14. (1890)
Journ. Mycol., Vol. vii, pp. 9 & 10. (1891)
U. S. Dep. Agr., Rep. for 1891, p. 377. (1892)
Dry-Rot (*Phoma Batatæ*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 23–25. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 76, p. 25. (1890)
Leaf-Spot (*Phyllosticta bataticola*, Ell. & Mart.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 27 & 28. (1890)
Scab (*Monilochætes infuscans*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 25–27. (1890)
Soft-Rot (*Rhizopus nigricans*, Ehrb.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 4–6. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 76, pp. 6 & 7. (1890)
Soil-Rot (*Acrocystis Batatas*, Ell. & Hals.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 14–18. (1890)
Treat. (rec.), N. J. Agr. Exp. Sta., Bull. 76, pp. 18–20. (1890)
Stem-Rot (*Nectria Ipomœæ*, Hals.)
See Egg-Plant (Stem-Rot.)
White-Rot (*Penicillium* sp.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 22 & 23. (1890)
White Rust (*Cystopus Ipomœæ-panduronæ*, (Schw.) Farl.)
Descr. Illus., N. J. Agr. Exp. Sta., Bull. 76, pp. 28–30. (1890)

Sycamore.

(*Platanus* spp.)

Anthracnose (*Glœosporium nervisequum*, (Fckl.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 387–389. (1889)
Treat. (rec.), U. S. Dep. Agr., Rep. for 1888, p. 389. (1889)
Cf. Journ. Mycol., Vol. v, p. 51 e. s.

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Tomato.

(*Lycopersicum esculentum*, Mill.)

Anthracnose (*Colletotrichum Lycopersici*, Chester.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 4, 1891, pp. 60–62. (1892)
Cf. Del. Agr. Exp. Sta., Rep. 5, 1892, p. 80. (1893)

Anthracnose (*Glœosporium phomoides*, Sacc.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 325. (1893)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–330.

Blight (Bacterial.)
Descr., Miss. Agr. Exp. Sta., Bull. 19. (1892)
N. J. Agr. Exp. Sta., Rep. 12, 1891, pp. 267 & 268. (1892)
N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 45, p. 218. (1892)
Cf. Cucumber, Melon, Potato and Squash (Blight.)

Blight (Bacterial?)
Descr., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 48, pp. 149–154. (1892)

Blight (Fungus, Sp. indet.)
Descr., Fla. Agr. Exp. Sta., Bull. 21, pp. 25–27. (1893)
Treat. (pos.), Fla. Agr. Exp. Sta., Bull. 21, pp. 32–36. (1893)

Downy Mildew (*Phytophthora infestans*, DBy.)
See Potato (Downy Mildew.)

Fruit-Mould (*Macrosporium Tomato*, Cke., and *Fusarium Solani*, (Mart.) Sacc.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 339–344. (1889)
Treat. (pos.), ? U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, pp. 61–65. (1890)

Leaf-Blight (*Macrosporium Solani*, Ell. & Mart.)
Occ., Del. Agr. Exp. Sta., Rep. 4, 1891, p. 62. (1892)
See Potato (Leaf-Blight.)

Scab (*Cladosporium fulvum*, Cke.)
Descr. Illus., U. S. Dep. Agr., Rep. for 1888, pp. 347 & 348. (1889)
Treat. (pos.), Journ. Mycol., Vol. v, p. 38. (1889)
U. S. Dep. Agr., Sec. Veg. Path., Bull. 11, p. 47. (1890)
N. C. Agr. Exp. Sta., Bull. 84, p. 21. (1892)
Conn. Agr. Exp. Sta., Bull. 115, p. 16. (1893)

Turnip.

(*Brassica compestris*, L.)

Club-Root (*Plasmodiophora Brassicæ*, Wor.)
See Cabbage (Club-Root.)

Downy Mildew (*Peronospora parasitica*, (P.) Tul.)
Occ., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 222. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 223. (1891)
Cf. Cabbage (Downy Mildew.)

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Powdery Mildew (*Oidium Balsamii*, Mont.)
Occ., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 61, pp. 305 & 306. (1893)
White Rust (*Cystopus candidus*, (P.) Lév.)
Occ., Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 222. (1891)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 8, 1890, p. 223. (1891)
Cf. Cabbage (White Rust.)

Verbena.

(*Verbena* sp.)

Powdery Mildew (*Erysiphe cichoracearum*, DC.)
Occ., N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 37, p. 405. (1891)
Treat. (pos.), N. Y. Corn. Univ. Agr. Exp. Sta., Bull. 37, p. 405. (1891)
Cf. Cucumber and Squash (Powdery Mildew.)

Violet.

(*Viola odorata*, L.)

Anthracnose (*Glœosporium Violæ*, B. & Br.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Downy-Mildew (*Peronospora Violæ*, DBy.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Leaf- Blight (*Cercospora Violæ*, Sacc.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)
Leaf-Spot (*Phyllosticta Violæ*, Desm.)
Descr., Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 231 & 232. (1893)
Treat. (rec.), Mass. Agr. Exp. Sta., Rep. 10, 1892, pp. 232–235. (1893)
Root-Rot (*Thielavia basicola*, Zopf.)
Descr., Conn. Agr. Exp. Sta., Rep. 15, 1891, pp. 166 & 167. (1892)
Leaf-Mould (*Zygodesmus albidus*, Ell. & Hals.)
Occ., N. J. Agr. Exp. Sta., Rep. 11, 1890, p. 362. (1891)

Watermelon.

(*Citrullus vulgaris*, Schrad.)

Anthracnose (*Colletotrichum lagenarium*, (Pass.) Ell. & Hals.)
Occ., N. J. Agr. Exp. Sta., Rep. 13, 1892, p. 326. (1893)
Treat. (neg.), Del. Agr. Exp. Sta., Rep. 5, 1892, p. 79. (1893)
Cf. N. J. Agr. Exp. Sta., Rep. 13, 1892, pp. 326–330.
Del. Agr. Exp. Sta., Rep. 5, 1892, pp. 78 & 79.
Cf. Melon (Anthracnose.)
Leaf-spot (*Phyllosticta* sp., and (?) *Sphærella* sp.)
Descr. Illus., Del. Agr. Exp. Sta., Rep. 5, 1892, pp. 75–78. (1893)

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Wheat.

(*Triticum vulgare*, L.)

Ergot (*Claviceps purpurea*, Tul.)

See Rye (Ergot.)

Rust (*Puccinia coronata*, Cda., *P. graminis*, P., and *P. Rubigo-vera*, (DC.) Wint.)

Descr. Illus., Ind. Agr. Exp. Sta., Bull. 26. (1889)
Iowa Agr. Exp. Sta., Bull. 16, pp. 324–326. (1892)
Kan. Agr. Exp. Sta., Bull. 38, pp. 1–3. (1893)
Treat. (neg.), Kan. Agr. Exp. Sta., Bull. 22, pp. 90–93. (1891)
Iowa Agr. Exp. Sta., Bull. 16, pp. 326–329. (1892)

Cf. Oats (Rust.)

Scab (*Fusarium culmorum*, Smith.)

Descr. Illus., Del. Agr. Exp. Sta., Rep. 3, 1890, pp. 89 & 90. (1891)
Ohio Agr. Exp. Sta., Bull. 44, pp. 147 & 148. (1892)
Descr., Ind. Agr. Exp. Sta., Bull. 36, pp. 129 & 130. (1891)
Iowa Agr. Exp. Sta., Bull. 18, pp. 502 & 503. (1892)

Smut (*Tilletia fœtans* (B. & C.) Trel., *T. Tritici*, (Bjerk.) Wint., and *Ustilago Tritici*, (P.) Jens.)

Descr. Illus., N. Dak. Agr. Exp. Sta., Bull. 1, pp. 9–20. (1891)
Mich. Agr. Exp. Sta., Bull. 87. (1892)
U. S. Dep. Agr., Div. Veg. Path., Farm. Bull. 5. (1892)
Treat. (pos.), Journ. Mycol., Vol. v, pp. 164 & 165. (1889)
Ind. Agr. Exp. Sta., Bull. 32, pp. 8 & 9. (1890)
Kans. Agr. Exp. Sta., Bull. 21, pp. 70 & 71. (1891)
Mich. Agr. Exp. Sta., Bull. 87, pp. 6 & 7. (1892)
U. S. Dep. Agr., Div. Veg. Path., Farm. Bull. 5, pp. 5–8. (1892)
Wash. Agr. Exp. Sta., Bull. 8, pp. 135 & 136. (1894)

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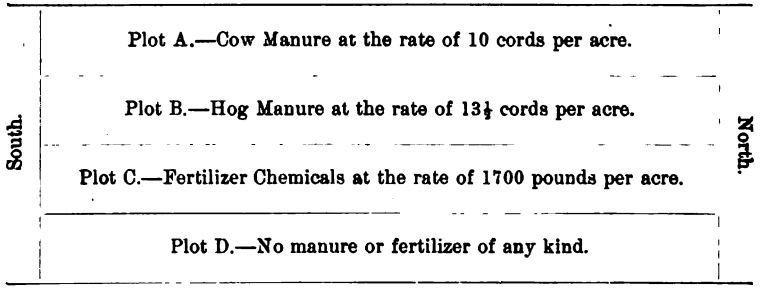
OBSERVATIONS ON THE GROWTH OF MAIZE CONTINUOUSLY ON THE SAME LAND.

In the years 1888 and 1889 a parcel of land containing 1¼ acres which had been a meadow for some years previous, was dressed with commercial fertilizers and planted to corn. Fertilizers and crops were weighed and analyzed each year and the enrichment or exhaustion of the soil by the dressing and cropping were as accurately determined as possible.

In the spring of 1890 this land was divided into four strips, each containing three-tenths of an acre, and was dressed as shown in the following diagram.


Plot A.—Cow Manure at the rate of 10 cords per acre.
Plot B.—Hog Manure at the rate of 13½ cords per acre.
Plot C.—Fertilizer Chemicals at the rate of 1700 pounds per acre.
Plot D.—No manure or fertilizer of any kind.
South.
North.

Corn was planted in drills four feet apart and the stalks stood singly at distances of ten inches in the drill. The crop from each plot was separately weighed and analyzed.

The several plots have received the same dressing as in 1890 annually since that time, have been planted with the same variety of seed and have been under the same conditions of planting, cultivation and harvesting.

Full particulars regarding the details of the experiment and the results obtained from year to year will be found in the Reports of this Station for 1890, pages 183 to 194; 1891, pages 139 to 149; and 1892, pages 122 to 129.

The experiment was repeated in 1893 precisely as in the three years previous.

The land was plowed May 23d, 1893, and planted with White Edge Dent, May 25th. The crop was "cultivated" four times, it was cut about the 20th of September, and was husked, weighed and housed Nov. 7th.

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Considering simply the gross amounts of nitrogen, phosphoric acid and potash which the dressing added to the soil of the several plots and those which the crops removed, it appears from Table VII., to be noticed later, that after the crop of 1893 was harvested there had been added to plot A *per acre, in excess of what had been taken off in crops*, over 700 pounds of nitrogen, 560 of phosphoric acid and 570 of potash, all from cow manure.

The corresponding enrichment of plot B consisted, *per acre*, of over 1,200 pounds of nitrogen, 2,330 of phosphoric acid and 68 of potash, all from hog manure. The very large excess of phosphoric acid in the hog manure is due to the fact that the hogs were fed chiefly on hotel garbage, which contained a large quantity of bones of fowls.

The enrichment of plot C, *per acre*, amounted to over 300 pounds of nitrogen, 683 of phosphoric acid and 129 of potash all from fertilizer-chemicals.

Plot D received fertilizer-chemicals in 1888 and 1889, but in the following four years no dressing of any sort; so that after the harvest of 1893 it had acquired, *per acre*, 73 pounds more of phosphoric acid (from the applications of 1888 and 1889), than the crops had removed, but had lost 257 pounds of nitrogen and 40 pounds of potash.

Plot B also received more "organic matter" from the dressing than plot A, while plot C acquired only an insignificant amount in the dressing of fertilizer-chemicals, and plot D none at all.

Plot A receives annually about 3,207 pounds, plot B about 5,440 pounds and plot C not more than 200 pounds of organic matter.

Gross Yield of the Plots in 1893.

Table I. presents the gross weight of the kernels, cobs and stover harvested on each plot. Inasmuch as the kernels were air-dried on the cob, the weight of the latter in the field-cured condition could not be taken. Hence the weight of the kernels given in the table is slightly higher and that of the cobs slightly lower than it should be. But the error is small.

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TABLE I.—GROSS YIELD OF THE PLOTS IN POUNDS PER ACRE. 1893.

	Plot A, Cow manure.	Plot B, Hog manure.	Plot C, Chemicals.	Plot D, No fertilizer.
Kernels	3536.4	3420.7	2630.2	1354.8
Cobs	480.0	455.0	345.5	166.8
Stover	4413.6	3504.3	3114.3	2078.4
	8430.0	7380.0	6090.0	3600.0

DRY MATTER OF THE CROPS OF 1893.

A strict comparison of the yields can only be made on their water-free substance, since the quantity of water in the field-cured crops is large and variable. Such a comparison is made below in Table II.

TABLE II.—DRY MATTER OF THE CROPS, POUNDS PER ACRE. 1893.

	In kernels.	In cobs.	In stover.	Total.
Plot A, cow manure	2223.0	428.7	2625.3	5277.0
Plot B, hog manure	2171.8	406.3	2441.4	5019.5
Plot C, fertilizer-chemicals	1537.9	308.5	2011.8	3858.2
Plot D, no fertilizer	748.5	149.0	1379.6	2277.1

The relative yields of dry matter from these plots for the last four years are given in Table III., the yield of plot A being marked in each case as 100.

TABLE III.—RELATIVE YIELD OF DRY MATTER FROM PLOTS A, B, C, D, FOR FOUR YEARS.

	Plot A.	B.	C.	D.
1890	100	104.7	89.5	73.5
1891	100	92.9	82.0	65.9
1892	100	114.6	98.3	48.9
1893	100	95.1	73.2	43.1
Average	100	102.2	86.6	60.1

It appears that the yields from plots A and B, both of which received heavy dressings of manure in excess of the exhaustion by cropping, have been essentially the same throughout the four years, that of B, however, being slightly larger, on the average.

The yield from C, which was fertilized with chemicals, also supplying considerably more nitrogen, phosphoric acid and potash

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than the cropping removed from the soil, is, on the average, somewhat more than four-fifths as large, while the yield of dry matter on the unmanured plot D has steadily fallen and averages but three-fifths of that from plot A.

Yield of Each Food Ingredient.

In Table IV., page 290, are given the quantities, in pounds per acre, of each food ingredient harvested from the four plots in 1893.

The cobs were not analyzed, but as their amount is relatively very small, the average composition of cobs as determined in other analyses, is used for the calculation.

The yield of each food ingredient from the four plots shows, in general, differences like those already noted in respect to the yield of total dry matter.

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TABLE IV.—YIELD OF FOOD INGREDIENTS IN POUNDS PER ACRE. 1893.

	PLOT A.				PLOT B.				PLOT C.				PLOT D.			
	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.
Water	1313.4	51.3	1788.3	3153.0	1248.9	48.7	1062.9	2360.5	1092.3	37.0	1102.5	2231.8	606.3	17.8	698.8	1322.9
Ash	27.9	6.7	194.3	228.8	28.0	6.4	156.3	190.7	18.4	4.8	121.8	145.0	8.2	2.5	94.1	104.6
Albuminoids	267.0	11.5	188.0	466.5	244.6	10.9	164.0	419.5	178.1	8.3	158.8	345.2	79.1	4.0	102.9	186.0
Fiber	46.0	144.5	908.8	1099.3	43.8	137.0	879.9	1060.7	30.8	104.0	698.2	833.0	16.5	50.2	445.2	511.9
Nitrogen-free extract	1778.8	263.6	1291.9	3334.3	1752.8	249.7	1206.9	3209.4	1243.8	189.7	1001.6	2435.1	612.9	91.7	717.7	1422.3
Fat	103.3	2.4	42.4	148.1	102.6	2.3	34.3	139.2	66.8	1.7	31.4	99.9	31.8	.8	19.7	52.2
	3536.4	480.0	4413.6	8430.0	3420.7	455.0	3504.3	7380.0	2630.2	345.5	3114.3	6090.0	1354.8	166.8	2078.4	3600.0

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Composition of the Field-cured Crops.

Table V., which follows, exhibits the composition of the crops on the four plots A, B, C, D, for the year 1893.

Table V.—Analyses of Field-cured Maize, Kernels and Stover, from Plots A, B, C, D. 1893.

	Analyses of Field-cured Maize.						Analyses, Calculated Water-free.				
	Water.	Ash.	Albumin-oids.	Fiber.	Nitrogen-free Extract.	Fat.	Ash.	Albumin-oids.	Fiber.	Nitrogen-free Extract.	Fat.
Kernels.											
Plot A	37.14	.79	7.55	1.30	50.30	2.92	1.26	12.01	2.06	80.02	4.65
" B	36.61	.82	7.15	1.28	51.24	3.00	1.28	11.26	2.02	80.71	4.73
" C	41.53	.70	6.77	1.17	47.29	2.54	1.19	11.58	2.00	80.89	4.34
" D	44.75	.61	5.84	1.22	45.23	2.35	1.11	10.56	2.21	81.85	4.27
Stover.											
Plot A	40.52	4.40	4.26	20.59	29.27	.96	7.39	7.16	34.62	49.22	1.61
" B	30.33	4.46	4.68	25.11	34.44	.98	6.40	6.71	36.04	49.44	1.41
" C	35.40	3.91	5.10	22.42	22.16	1.01	6.04	7.90	34.71	49.79	1.56
" D	33.62	4.53	4.95	21.42	34.53	.95	6.83	7.45	32.26	52.02	1.44

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The experiments of the four years show striking differences in the composition both of the kernels and of the stover, differences which are to be attributed to the fertilizers applied, and are presented in Table VI.

TABLE VI.—AVERAGE COMPOSITION OF THE DRY MATTER OF KERNELS AND STOVER OF CROPS OF 1890, 1891, 1892 AND 1893.

	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
KERNELS.					
Plot A	1.40	11.07	1.61	80.70	5.22
" B	1.40	10.74	1.62	81.09	5.15
" C	1.29	10.47	1.67	81.54	5.03
" D	1.26	9.52	1.80	82.57	4.85
STOVER.					
Plot A	6.64	6.17	33.06	52.68	1.45
" B	6.25	6.34	33.21	52.76	1.44
" C	6.15	6 44	33.06	52.96	1.39
" D	5.89	6.08	32.66	53.96	1.41

The dry matter of the kernels from the unfertilized plot D, contains one and a half per cent. less of albuminoids, one third per cent. less of fat and somewhat less ash-ingredients than the dry matter of kernels raised on plot A, which was heavily manured each year. The per cents of nitrogen-free matter and fiber in the kernels from plot D are, on the contrary, higher than in the kernels from plot A.

The kernels from plot C dressed with chemicals, which supplied each year an amount of nitrogen, phosphoric acid and potash greater than the amount removed by the crop, also have a lower per cent. of albuminoids, fat and mineral matter than the kernels from plots A and B, but a higher per cent. of fiber and nitrogen-free extract.

The striking differences in composition of dry matter between the crop from plot D and those from plots A and B illustrate the well-known fact that a deficiency of plant food reduces the quality as well as the quantity of the crop, and affects not only the merely vegetative parts of the plant but also the seed which is least variable in chemical composition.

So far as the differences, in chemical composition and total crop, between plot C, which was dressed with fertilizer-chemicals, and plots A and B which were treated with manure, are signifi-

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cant, they are probably due to other causes than different quantities of crude plant food supplied by the dressing. Plot C has received each year nitrogen, phosphoric acid and potash in surplus, over the quantity removed by the crop, now amounting to more than 300 pounds of nitrogen, 683 of phosphoric acid and 129 of potash. It is not likely that all of this nitrogen is now present in readily available form in the soil, but a considerable portion of this excess is probably now in the soil and is not entirely inert. The same is true of the phosphoric acid and potash. Hence while the *excess* of these ingredients is much greater on plots A and B it is difficult to believe that either of them is relatively deficient in plot C.

The poorer yield and inferior quality of crop on plot C are probably connected with the mechanical and physical condition of the soil which has been greatly modified, in the course of these four years, by the dressing applied. The fact that plot C has received very little organic matter (not more than 200 pounds a year), while A and B have had large dressings of it annually (from 3,000 to 5,000 pounds), has been already noticed.

To complete the data regarding this experiment are given the following tables.

Table VII. gives the quantities of nitrogen, phosphoric acid and potash, in pounds per acre, which were added to the soil in the dressing of 1893 and those which were removed by the crop. It also gives the amounts of these ingredients which have been added to the soil-capital (+) or withdrawn (−) in the six years during which accurate account has been kept.

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TABLE VII.—ENRICHMENT OR IMPOVERISHMENT OF SOIL BY SIX YEARS' MANURING AND CROPPING, POUNDS PER ACRE.

	Cow Manure. Plot A.			Hog Manure. Plot B.			Fertilizer Chemicals. Plot C.			No Fertilizer. Plot D.		
	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.
After five years' cropping..	+494.5	+447.0	+440.4	+855.0	+1766.4	+43.4	+184.1	+536.7	+95.9	−227.1	+82.5	−29.3
Applied in 1893.....	286.3	136.4	204 5	419 9	586.5	72.4	172.0	162.0	69.0	00.0	00.0	00.0
Taken off in Crop of 1893 .	74.6	21.6	74.4	67.1	22.9	47.3	55.2	15.4	35.5	29.8	8.9	10.7
Excess (+) or Deficiency (−) after six years' cropping.....	+706.2	+561.8	+570.5	+1207.8	+2330.0	+68.5	+300.9	+683.3	+129.4	−256.9	+73.6	−40.0

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TABLE VIII.—YIELD OF DRY MATTER AND "SHELLED CORN" PER ACRE FOR SIX YEARS AND COMPOSITION OF DRY MATTER.

	Year.	Distance of Planting.	Pounds of Dry Matter per Acre.	Bushels of Shelled Corn.	Percentage Composition of Dry Matter				
					Ash	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
Fertilized alike with chemicals	1888	Stalks 12 inches apart.	7350	75	3.3	7.8	19.4	66.1	3.4
	1888	" 6 " "	7980						
	1889	" 12 " "	6144	60	3.5	6.1	21.7	69.7	3.0
	1889	" 6 " "	6353						
Cow Manure	1890A	" 10 " "	9014	91	4.0	7.9	19.8	65.7	2.6
Hog Manure	1890B	" 10 " "	9436	97	4.2	8.0	19.6	65.5	2.7
Fertilizer Chemicals	1890C	" 10 " "	8070	87	3.9	8.0	21.2	64.4	2.5
No Manure or Fertilizer	1890D	" 10 " "	6626	51	3.8	6.2	20.7	66.7	2.6
Cow Manure	1891A	" 12 " "	8176	103	3.2	7.5	15.5	70.2	3.6
Hog Manure	1891B	" 12 " "	7599	88	3.3	7.6	16.2	69.3	3.6
Fertilizer Chemicals	1891C	" 12 " "	6708	70	3.2	6.4	18.5	68.8	3.1
No Manure or Fertilizer	1891D	" 12 " "	5391	60	3.1	6.0	17.4	70.2	3.3
Cow Manure	1892A	" 12 " "	7181	72	4.0	8.2	19.6	65.1	3.1
Hog Manure	1892B	" 12 " "	8233	84	4.0	8 8	19.3	64.8	3.1
Fertilizer Chemicals	1892C	" 12 " "	7062	86	3.2	8.3	17.5	67.8	3.2
No Manure or Fertilizer	1892D	" 12 " "	3509	38	3.3	7.7	18.8	67.2	3.0
Cow Manure	1893A	" 12 " "	5277	53	4.3	8.8	20.8	63.3	2 8
Hog Manure	1893B	" 12 " "	5020	52	3.8	8.4	21.1	63.9	2.8
Fertilizer Chemicals	1893C	" 12 " "	3858	37	3.8	9.0	21.6	63.0	2.6
No Manure or Fertilizer	1893D	" 12 " "	2277	18	4.6	8.2	22.5	62.4	2.3

Table VIII. gives the record of the crops on the four plots for the whole period covered by the experiment and also the percentage composition of the several crops.

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The Quantity of Nitrogen in the Soils of the Experimental Plots.

Samples of soil were drawn for analysis in the fall of 1891. The previous history of the plots has been already given on pages 286–7.

The following statement shows how much nitrogen, phosphoric acid and potash had been added to or taken from the original soil-capital, by four years' dressing and cropping, at the time the soils were sampled for analysis. When the whole quantity put on in dressing was greater than that taken off in cropping the excess is marked with the plus (+) sign; when the quantity put on in dressing was less than the quantity removed in cropping this deficiency is marked by a minus (−) sign.

Table IX.—Increase or Decrease of Soil-Capital, from April, 1888, to October, 1891.

	Plot A.	Plot B.	Plot C.	Plot D.
Nitrogen	+302	+ 551	+106	−184
Phosphoric acid	+340	+1220	+404	+ 97
Potash	+331	+ 72	+ 92	− 11

On Oct. 6th, 1891, during moderately dry weather which had prevailed since early in September, four samples of surface soil—from places about equidistant and between the corn rows—were drawn from plot A, four from B, and two each from C and D.

The samples were drawn with a rectangular iron instrument like a box without bottom or cover. The lower edge of this was sharp to divide the soil, the upper edge was wired so as to stand moderate pressure without yielding. This sampler was 8 inches deep, 6 inches long and 6 inches wide.

It contained when full, one-sixth of a cubic foot of earth and enclosed one-quarter of a square foot of surface.

On the spot selected, this sampler was forced down till its upper edge was flush with the surface of the soil. As the sampler was forced down, the soil outside was cut away with a mason's trowel, when necessary, to lessen friction and to remove obstructing pebbles. When the sampler had been driven to the proper depth, the surrounding earth was removed and the trowel was passed horizontally through the soil at the lower edge of the sampler. The enclosed portion of earth constituting the sample could then be lifted without loss, with the trowel under it.

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A board was laid on the section of earth above which the sample had been taken, to mark the spot for future reference and to protect it. The hole was then covered with earth till Oct. 28th, when samples of the subsoil were drawn.

The samples of surface soil obtained on the 6th were immediately weighed. From the several samples drawn on each plot smaller samples were taken for separate analysis, and then the remainders of the principal samples from each plot (four on plots A and B, two each on C and D) were thoroughly mixed, thus making a composite sample from each plot. A weighed quantity of each of these samples was quickly dried at a temperature of from 50° to 55° C., and after standing for some time to "air-dry" was again weighed and securely bottled.

The four samples from plot A were first examined to learn what variations of water-content, and of composition otherwise, different parts of the same plot might exhibit.

Each sample was first sifted on round holes $\frac{1}{2}\frac{1}{5}$ of an inch in diameter. The two portions into which the soil was thus separated will be referred to as "coarse earth" and "fine earth." That part of the "coarse earth" from the four samples which passed holes $\frac{1}{1}\frac{1}{2}$ inch in diameter was finely pulverized and its nitrogen determined, by the absolute method, in 10 grams. There was found only 0.024 per cent. Since this portion that passed a $\frac{1}{1}\frac{1}{2}$ inch sieve constitutes not more than half of the "coarse earth" and probably contains practically all of its nitrogen, the nitrogen of the "coarse earth" is so little that it may be disregarded without introducing serious error into calculations. The results of examination of the several portions of soil taken from plot A, are given in the following table.

TABLE X. — WATER AND NITROGEN IN FOUR SAMPLES OF SURFACE SOIL FROM PLOT A.

	Grams of fresh Soil.	Grams of air-dry Soil.	Per cent. of water lost in air-drying.	Grams of coarse Earth.	Grams of fine Earth.	Per cent. of Nitrogen in fine Earth.	Per cent. of Nitrogen reckoned on entire air-dry surface Soil.
A1	500	450.3	9.9	43.5	406.8	0.174*	0.157
A2	500	446.0	10.8	49.5	396.5	0.162	0.144
A3	500	450.0	10.0	59.5	390.5	0.156	0.135
A4	500	439.2	12.2	53.5	385.7	0.170	0.150
Average..	500	446.4	10.7	51.5	394.9	0.165	0.147

The above figures serve to indicate what are the limits of accuracy of ordinary chemical analysis as applied to this soil.

* Duplicate analyses gave 0.176 and 0.172 p. c.

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The greatest difference in the amounts of nitrogen found in the fine earth of the four samples, taken from widely separate portions of plot A, is 0.018 per cent. of the soil, or about one-ninth of the average of total nitrogen. The widest divergence from the mean is 0.009 per cent. of the soil, or one-eighteenth of the average total quantity of nitrogen. This 0.009 per cent. corresponds to 233 lbs. of nitrogen per acre of this soil, taken to the depth of 8 inches. The agreement of duplicate analyses* on the same sample is better than could be commonly expected. The differences among the quantities found in the several samples are not greater than might easily occur in several analyses of the same sample. When we reckon from the sample to the acre, the slight and unavoidable errors or variations of analysis mount up to hundred-weights and the results of such calculation must be received with due allowance. They are nevertheless instructive and valuable.

The quantities per cent. of nitrogen found in the composite samples from the surface of the plots (*sursoils*), are stated in Table XI., together with other data obtained by calculation from the weights of the samples in their fresh, air-dry and sifted condition.

Table XI., also comprises the results of similar analyses and calculations made with samples of subsoil, taken on October 28th, by the method already described. These samples represent successive horizontal sections of the plots in 8-inch depths, as stated at head of table.

TABLE XI.—WATER AND NITROGEN IN SURSOIL AND SUBSOIL OF PLOTS A, B, C, D.

	Sursoil	Subsoil		
	0 to 8 in.	8 to 16 in.	16 to 24 in.	24 to 32 in.
	WATER LOST IN AIR-DRYING, PER CENT.			
Plot A	9.38	9.76	9.37	4.46
" B	10.64	11.61	11.70	....
" C	8.33	10.54	5.86	....
" D	9.27	8.93	6.60	....
	WEIGHT OF AIR-DRY SOIL, POUNDS PER ACRE.			
Plot A	2,585,695	2,830,215	3,000,361	3,079,675
" B	2,605,425	2,733,691	2,787,971	....
" C	2,660,336	2,805,752	3,034,546	....
" D	2,696,061	2,856,247	3,173,433	....

* See footnote on page 297.

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	Sursoil to 8 in.	Subsoil 8 to 16 in.	Subsoil 16 to 24 in.	Subsoil 24 to 32 in.
	NITROGEN IN AIR-DRY "FINE EARTH," PER CENT.			
Plot A	0.173	0.050	0.027	0.012
" B	0.182	0.089	0.037	....
" C	0.158	0.060	0.018	....
" D	0.133	0.033	0.012	....
	NITROGEN IN ENTIRE SAMPLE, PER CENT.			
Plot A	0.140	0.031	0.016	0.008
" B	0.143	0.067	0.029	....
" C	0.130	0.050	0.013	....
" D	0.109	0.025	0.009	....
	TOTAL NITROGEN, POUNDS PER ACRE.			
Plot A	3620	877	480	237
" B	3726	1831	808	....
" C	3458	1403	394	....
" D	2939	714	285	....

NOTE REGARDING METHODS OF ANALYSIS.

Nitrogen was determined in 10 grams of the soils very finely pulverized, by the Dumas or "absolute" method. This quantity of surface soil yielded approximately 14 or 15 c. c. of nitrogen gas.

The apparatus, reagents and manipulation were checked by determining nitrogen in a sample of dried blood which had been carefully analyzed by both the absolute and Kjeldahl methods in 1886 and had then shown 13.40 per cent. of nitrogen.

With the same apparatus and reagents used in these soil-analyses this sample of blood gave 13.45 per cent. of nitrogen by the absolute method and 13.44 and 13.59 per cent. by the Kjeldahl method.

It was also sought to determine nitrogen in the soils by the Kjeldahl and the Jodlbaur-Kjeldahl methods as follows:

Kjeldahl Method.—This was executed in the ordinary way, using 30 c. c. of oil of vitriol instead of 20 c. c.

Jodlbaur-Kjeldahl Method.—To 10 grams of soil, in a digestion flask, were added 10 c. c. of acid-mixture (60 grams salicylic acid in 1,000 c. c. of concentrated oil of vitriol of 66° B.). After standing in the cold for 24 hours, 30 c. c. of oil of vitriol and 1 gram of zinc dust were added, the contents of the flask were

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boiled till colorless and the ammonia was determined by distillation as usual.

As the following table shows, the agreement of results between these three methods is entirely satisfactory to the chemist. The extreme difference among the eleven determinations is 0.032, the greatest divergence from the average of all is 0.017 and the largest difference on the same subsample is but 0.014 per cent.

PER CENT. OF NITROGEN FOUND.

Sample of Surface Soil.	Dumas Method.	Kjeldahl Method.	Jodlbaur-Kjeldahl Method.	Average by three methods.
A, 1	0.174	----	0.163	0.169
A, 2	0.162	0.150	0.150	0.154
A, 3	0.156	0.156	0.142	0.151
A, 4	0.170	0.159	0.160	0.163
Average	0.166	0.155	0.154	
Average of Averages,		0.158		0.159

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ANALYSES OF MAIZE KERNEL.

In the following tables are given analyses of ninety samples of maize kernel together with data regarding the weights of kernel and cob, ratio of weight of kernel to weight of cob, and other information of interest.

The specimens whose analyses are here given were collected in part by Prof. C. S. Phelps and in part by this Station for the Connecticut Exhibit at the Chicago Exposition. The analyses were made in the Station laboratory during 1892 and 1893. The other data in the Tables were furnished by the senders, in answer to a Circular issued in November, 1891. See Report for 1891, p. 196. A few ears of each variety are preserved in the Museum of this Station.

Many of these varieties have been raised continuously on the same farm for a long term of years, the seed having been selected with more or less care each year. The samples were gathered and sent by the growers and probably represent the best of the crop rather than the average.

In studying the tables of analyses it should be remembered that the composition of any specimen is dependent not only on the strain or variety, but also to some degree on the nutrition of the plant. That is, other things being equal, the shelled maize harvested from well-conditioned land, contains, pound for pound, somewhat more protein, fat and ash than that yielded by the same variety of corn, from an impoverished soil.

On page 291 of this Report may be seen a statement of such difference of composition in two samples of White Edge Dent, raised side by side in the same field with and without manure. The grain from the enriched soil, considered water-free, contains 11.26 to 12.01 per cent., that from the unmanured land but 10.56 per cent. of albuminoids (protein $= N \times 6.25$).

To demonstrate any constant difference in the chemical composition of different varieties it would be necessary to produce them under the same conditions of soil, climate, manuring and tillage for a number of years.

The Station solicits samples—of a dozen ears each—of other varieties of corn, preferably those which have been cultivated for a long term of years, in this State, in order to complete our collection of Connecticut varieties and our knowledge of their composition.

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No.	Name of Variety.	Class.	Sender's Name and Residence.	No. years raised on same farm.	Date of planting.	Date of cutting.	Distance of hills in the row and between rows, in feet.	Number of stalks in hill.
1	Queen of the Prairie.	Yellow dent.	W. H. Brinsmade, Nichols.	1	June 2	Oct. 3	3½ × 3½	4–5
2	8-Rowed Yellow.	Yellow flint.	Henry Belden, Falls Village.	100	May 26	Nov. 3§	-------	---
3	White Dent.	White dent.	W. H. Brinsmade, Nichols.	25	" 28	Sept. 25	3½ × 3½	4
4	Rhode Island White Cap.	White flint.	H. S. Frost, Cheshire.	---	-------	-------	-------	---
5	Prairie Queen.	Yellow dent.	M. S. Dyer, Canton.	---	-------	-------	-------	---
6[1]	A, Rhode Island White Cap.	White flint.	E. P. Barnes, Norwich.	12	May 10	Sept.	3 × 3½	4
6[2]	B, Red variety of A.	Red flint.	" " "	---	-------	-------	-------	---
7	Beers' Yellow Corn.	Yellow flint.	N. S. Platt, Cheshire.	---	-------	-------	-------	---
8	The Brainard Corn.	"	T. J. Stroud, Shaker Station.	50	-------	-------	-------	---
9	Rhode Island Cap.	White flint.	J. J. Copp, Groton.	40	May 20	Aug. 15	3½ × 3½	4
10	Early Eight-rowed Canada.	Yellow flint.	" " "	3	" 20	" 15	3½ × 3½	4
11	Red Blaze.	White flint.(!)	" " "	30	" 10	" 25	3½ × 3½	4
12	Conn. Eight-rowed Yellow Flint.	Yellow flint.	Wm. J. Jennings, Green's Farms.	60	-------	Sept. 1	-------	3–4
13	Allen Corn.	White flint.	A. T. Allen, North Ashford.	75	-------	" 7	2½ × 3	4
14	Queen of the Prairie.	Yellow dent.	John Ellwood, Green's Farms.	15	-------	" 1	3½ × 3½	4
15	China Corn (China Tea), (China Tree).	White dent.	Bradley Goodsell, Green's Farms.	48	-------	" 10	3½ × 3½	---
16	White Flint.	White flint.	W. J. Jennings, Green's Farms.	---	-------	" 5	3½ × 3½	---
17	Farmers Pride.	White dent.*	P. K. Hoadley, North Guilford.	5	June 4	" 12	2 × 3½	4
18	Longfellow.	Yellow flint.	S. H. Peck, Watertown.	10	-------	" 22	3½ × 3½	3–5
19	Bolton.	"	L. Willey, East Hampton.	40	-------	" 15	3 × 3½	4
20	Bolton.	"	" "	---	-------	-------	-------	---
21	Hickox Improved Sugar Corn.	Sweet.	D. Fenn & Son, Milford.	20	-------	Oct. 15	3½ × 3½	3–4
22	Pride of the North.	Yellow dent.	F. S. Hall, Guilford.	---	-------	-------	-------	---
23	Sanford.	White flint.	Richard Wilcox, Guilford.	19	May 10	Oct. 5	4 × 4	4–5
24	Benton.	Yellow dent.	D. R. Spencer, Guilford.	100	" 10	" 25	4 × 4	4–5
25	Angel of Midnight.	Yellow flint.	J. H. Blatchley, Guilford.	---	-------	-------	-------	---
26	Bird Track.	Red flint.	Ed. Davis, Guilford.	---	-------	-------	-------	---
27	Early Ohio.	Yellow dent.*	Richard Wilcox, Guilford.	25	May 1	Sept. 27	4 × 4	3–5
28	White Dent.	" †	" " "	6	" 4	Oct. 1	4 × 4	4
29	Early Mastodon.	" †	-------	---	-------	-------	-------	---

* Red markings. † Between white and yellow. § Harvest.

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Average yield of shelled corn in bushels.	Average height of stalks in feet.	Character of Soil.	Manure and Cultivation.	Remarks.
35	10			Stalks coarse, not as leafy as some.
			Cultivated and hoed twice.	Damaged by hail storm.
42	10–12		Followed rye. Barnyard manure.	Seed originally from Scioto Valley, Ohio.
25–30	7		Manure plowed in in fall. 200 lbs. fertilizer and 200 hen manure put in hill. Hoed twice in June.	Length of ear and size of kernel have increased under cultivation.
				This variety planted to cross with previous one.
				Brought from Canada to Vt. in 1837. From Vt. to Haddam, Ct., 1842. From Haddam to Enfield in 1854 and grown there ever since.
50	5½–6½		25 ox-cart loads of manure. 300 lbs. fertilizer in hill.	Grows larger than formerly.
40	7		6 cords cow manure plowed in. 200 lbs. fertilizer in hill.	Has not changed under cultivation.
50	7–8		8 cords manure plowed in. 200 lbs. fertilizer in hill. Cultivated and hoed twice.	" " " "
40	7–8			Ripens 10–15 days earlier than formerly. Produced more ears and better tipped ones.
65	8		Manure spread. Fertilizer in hill. Cultivate 3 times, hoe twice.	
55	7–8			Ears have grown larger under cultivation.
50–60	7–8			Seed from Long Island originally. Later in ripening and less indented than formerly.
45	6½–9			Shows some mixture with yellow varieties.
55	8			Select seed to grow small cobs, capped ears and regular rows.
150*	7			Ripens 2–3 weeks earlier than formerly.
40	6		Manure plowed in in May. 400–600 lbs. hen manure and plaster in hill.	
			20 loads manure. 600 lbs. bone, half in hill and half between rows at first hoeing.	
35	7–8		Manured after plowing. Harrowed in.	Selects seed to produce ears of uniform size.
50	6–7		Manured in winter. 400–600 lbs. fertilizer.	Valuable for fodder. Suckers. Ears not as long as formerly.
65	7½		Raised on barn yard manure. Cultivate 3 times, hoe once.	Has not so large a cob and does not need so long a season as formerly.
50–80	7		Liberal dressing necessary. Cultivate level and shallow.	Shells more corn to the bushel of ears than any he has raised.
60–70†	7–8		Plenty of manure. 300 lbs. fertilizer in hill.	More apt to mix than other varieties. Not good for fodder. Stalks large.

* Ears. † Maximum.

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No.	Name of Variety.	Class.	Sender's Name and Residence.	No. years raised on same farm.	Date of planting.	Date of cutting.	Distance of hills in the row and between rows in feet.	Number of stalks in a hill.
30	Eight-rowed Yellow.	Yellow flint.	Bradley Miles, Cheshire.	---	-------	-------	-------	---
31	Sanford.	White flint.	E. Woodruff, Guilford.	10	May 7	Oct. 10†	4 × 4	4–5
32	Scioto.*	Red dent.	Thomas Gilbert, Middletown.	---	May 20	Sept. 20	-------	---
33	Eight-rowed Dent.	Yellow dent.	Thomas Scott, Farmington.	65	" 25	Oct. 1	3½ × 3½	3
34	Red Blade Field Corn.	White flint.	Selden S. Carter, Clinton.	20	June 2	Sept. 16	3½ × 3½	---
35	Red Rose Field Corn.	Red flint.	Geo. L. Rosebrooks, Storrs.	26	May 20	" 10	3½ × 3½	4
36	Storrs' Improved Field Corn.	Yellow flint.	Geo. L. Rosebrooks, Storrs.	24	" 20	" 10	3½ × 3½	4
37	Sill's Golden Sheaf or Prolific.	"	Samuel A. Chalker, Saybrook.	3	" 20	" 10	3½ × 3½	3–5
38	King Philip.	Red flint.	H. F. Dimock, So. Coventry.	---	-------	-------	-------	---
39	Twelve-rowed Flint.	Yellow flint.	John S. Wells, Hebron.	30	May 18	Sept. 12	3½ × 3½	---
40	Scioto.	White dent.	A. L. Congdon, Westfield.	10	" 10	Sept. 15	3½ × 3½	4
41	Brigner's Corn.	Yellow flint.	Stephen Brigner, Falls Village.	25	" 12	Sept. 20	3½ × 3½	---
42	Improved Canada Corn.	"	Chauncey Deming, Farmington.	6–8	" 30	" 6	3½ × 3½	---
43	Canada Improved Corn.	"	M. W. Frisbie, Southington.	---	June 10	" 18	-------	---
44	Ayers' Poor Land Corn.	"	E. C. Ayer, Farmington.	20	May 18	Sept.	3½ × 3½	3–4
45	Early Diamond Corn.	"	W. J. Simpson, Plainville.	---	" 10	" 1	3½ × 3½	---
46	Cross Small Yellow Cap and Angel of Midnight.	"	J. J. Williamson, Woodstock.	---	June 8	" 12	-------	---
47	Self-Husking Corn.	Red flint.	Jasper S. Brooks, Moodus.	5	" 1	" 1–10	3 × 3½	3–5
48	Queen of the North.	Yellow dent.	F. E. Boardman, Westfield.	1	May 11	" 15	3½ × 3½	4–5
49	Early Butler Dent.	"	Elbert Manchester, Bristol.	---	" 20	Oct. 1	3½ × 3½	---
50	Ashley's Prolific.	Yellow flint.	Carlos Bradley, Ellington.	20	" 8–12	Sept. 1	3½ × 3½	3–5
51	Horse Tooth Dent.	White dent.	H. E. Savage, E. Berlin.	4	" 17	" 16	Drills.‡	---
52	Echo Farm Pride.	Yellow flint.	J. B. & L. H. Healy, N. Woodstock.	3	" 30	Nov. 1†	3½ × 3½	4–5
53	Golden Beauty.	Yellow dent.	Geo. W. Thorpe, Meriden.	3	" 1	Oct. 25†	1 × 3½	1

* Cross of 2 varieties brought from Ohio in 1884. † Harvest.
‡ 2 ft. apart in drill. Drill 3½ ft. apart.

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Average yield of shelled corn in bushels.	Average height of stalks in feet.	Character of Soil.	Manure and Cultivation.	Remarks.
55	9			
60	.....	Clay loam to red clay.	Cultivate 3 times, hoe twice.	
100*	6–7	Sandy loam.	20 loads manure. Spoonful of fertilizer in hill. Cultivate both ways.	
50	5	Light, high and dry.	8 cords manure.	Size of ears has increased under cultivation.
75	.....	Clay loam.	Stable manure.	From a cross of unnamed varieties made 26 years ago.
75	8–10	" "	40 loads manure. Plow in August. Harrow in spring and spread manure and plow it under. Cultivated 3 times, hoed twice.	
75	6–7	Heavy loam.	Cultivated level and often.	
60	.....	Loamy.	15 loads manure, 400 lbs. fertilizer. Both spread and plowed in. Cultivated twice both ways. Hoed twice.	Picked ears to ripen on ground and silage the stalks.
60	7	Gravelly.	600 lbs. fertilizer per acre. Cultivated and hoed 3 times.	
120*	7	Sandy loam.	20 loads manure. Cultivated and hoed twice.	Originally came from Canada. Length of ear has increased.
125*	.....	" "	Manure on turf plowed in. A little fertilizer put on after planting. Cultivated flat both ways.	Stalks and ears are larger and longer than formerly.
100*	.....	Worn out meadow.	Cultivated and hoed twice.	
40	.....	Sandy loam.	Cover in with tobacco ridger. Mark across the ridges for planting. Level culture. 500 lbs. Castor Pomace, 150 lbs. Muriate of Potash, 200 lbs. Bone Superphosphate.	
125*	.....	Sandy.		
100*	.....	Loam. Clayey subsoil.	Manure plowed in. Fertilizer in the hill.	
100*	.....	Gravelly loam.	Cultivated and hoed twice.	
45	9	Loam.	Light dressing of manure. 400 lbs. fertilizer in the hill. Cultivated and hoed twice.	
100	.....	Red loam.		
40–50	.....	Gravelly loam.	10–15 loads manure plowed in. Fertilizer in hill. Cultivated both ways and used Prout hoe.	
50	8	Clay loam.	6 cords manure on sod. Cultivated 4 times, hoed once.	Came from W. Va. Has grown more like a flint corn.
50	7	Loam. Clayey subsoil.	25 loads of manure. Cultivated twice, hoed once.	
75	10	Lightloam,stony	Cultivated 3 times, hoed once.	

* Ears.

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No.	Name of Variety.	Class.	Sender's Name and Residence.	No. years raised on same farm.	Date of planting.	Date of cutting.	Distance of hills in the row and between rows in feet.	Number of stalks in a hill.
54	Nevins' Improved.	Yellow dent.*	Stephen Hoyt's Sons, New Canaan.	---	June 2	Sept. 20	3 × 3	4
55	New Canaan Improved.	Yellow flint.	Stephen Hoyt's Sons, New Canaan.	---	May 25	" 20	3½ × 3½	---
56	Leaming.	Yellow dent.	H. E. Savage, E. Berlin.	7	" 26	" 20	3½ × 3½	---
57	R. I. State Premium.	Red flint.	Geo. Kane, Rockville.	1	" 24	" 20	2 × 3	4
58	Top Over Field Corn.	Yellow flint.	C. H. Matthews, Bristol.	---	" 28	" 5	-------	---
59	Holden Corn.	"	E. W. Upham, Union.	20	June 1	"	2 × 3½	4
60	Windsor Corn.	----------	H. H. Knox, W. Suffield.	17	April 25	"	4 × 4	---
61	Early Red Flint.	Red flint.	Chas. C. Shelden, W. Suffield.	12	May 17	Oct.	3½ × 3½	---
62	Minnesota King.	Yellow dent.	Warren A. Doolittle, Clinton.	2	" 10	Sept. 5	3 × 3½	2
63	Ohio Dent.	White dent.	R. F. Woodford, Plainville.	2	-------	" 1	4 × 4	4
64	Golden Dent.	Yellow dent.	R. F. Woodford, Plainville.	6	May 3	" 1	4 × 4	3–4
65	Chittenden.	Yellow flint.	Russell Church, Westbrook.	---	" 15	LateSept.	3½ × 3½	---
66	Saltzer's Ensilage.	White dent.	F. E. Boardman, Westfield.	1	" 9	Oct. 3	1½ × 3½†	---
67	Long Island Dent.	"	D. D. Hurd, Clinton.	12	" 15	Sept. 1	4 × 4	4
68	Arnold Field Corn.	Yellow flint.	Arnold Warren, S. Coventry.	30	" 10	" 1	3½ × 3½	4
69	Blake's Yellow Flint.	"	E. F. Blake, New Britain.	35	" 10	" 1	-------	---
70	Kissing Corn.	Red flint.	Samuel A. Chalker, Old Saybrook.	2	" 20	" 15	3½ × 3½	3–5
71	Hickory King.	White dent.*	Samuel A. Chalker, Old Saybrook.	1	-------	Oct. 1	4 × 4	---
72	Early Canada.	Yellow flint.	Samuel A. Chalker, Old Saybrook.	3	Late May	Sept. 15	3½ × 3½	3–5
73	New England Dent.	White dent.	D. H. Van Hoosear, Hurlburt St.	14	May 10	" 20	3⅜ × 3⅜	4–5
74	Dutton.	Yellow flint.	A. W. Darrow, Watertown.	---	" 25	" 20	3 × 3	---
75	R. I. Premium.	White flint.*	H. D. Hale, Glastonbury.	---	June 1	Oct.	3 × 3½	---
76	90 Day Canada.	Yellow flint.	" " "	---	"	1 "	3½ × 3½	---
77	Tyler.	White dent.	J. R. Campbell, Wallingford.	25	May 15	Sept. 15	3⅜ × 3⅜	7–8
78	12-Rowed Canada.	Yellow flint.*	John E. Tryon, So. Glastonbury.	20	June 1	"	3½ × 3½	---
79	Brindle.	Red flint.	N. S. Platt, Cheshire.	---	May 20	" 12	3¾ × 3¾	---

* Indentations slight.

† Probably in drills.

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Average yield of shelled corn in bushels.	Average height of stalks in feet.	Character of Soil.	Manure and Cultivation.	Remarks.
50	.....	Gravelly loam.	Cultivated 4 times, hoed 3 times.	.....
75*	.....	Drained muck swamp.	No manure. Cultivated both ways 5 times and hoed.	.....
60	8	Clay loam.	6 cords manure. Small quantity fertilizer in hill. Cultivated both ways 4 times and hoed.	.....
65	.....	Light loam.	25 loads manure. Plaster and ashes in hill.	.....
100*	.....	Sandy loam.	Hand hoed.	.....
60	5	.....	40 loads manure, 400 lbs. fertilizer.	.....
40	.....	Sandy loam.	25 ox-cart loads manure, 400 lbs. fertilizer in hill. Cultivated and hoed twice.	.....
65	8	" "	20 loads manure. 500 lbs. fertilizer in hill.	Bought seed for Canada Improved. Selected red ears for seed, which gave early and prolific corn.
100*	6	" "	Barnyard manure. Cultivated twice.	Seed came from Minnesota.
55	.....	" "	Harrow with smoothing harrow as soon as it came up. Cultivate both ways.	.....
65	8–10	" "	4 cords coarse manure. Handful of fertilizer in the hill. Cultivate both ways.	.....
90*	.....	Gravelly loam.	.....	.....
90	13	Clayey loam.	Stable manure plowed in. Hen manure in hill. Cultivated and hoed twice.	Does not fully mature. Excellent for silage.
50	.....	.....	.....	.....
50	6	Light, sandy.	20 cart loads stable manure per acre.	Obtained by crossing a number of varieties.
120*	.....	Clay loam.	Flat cultivation.	.....
75	7	Heavy loam.	Cultivated level and often.	.....
.....	12	.....	.....	Late. Very large. Good for silage.
60	6–7	Heavy loam.	Stable manure.	.....
45	5½	.....	.....	Have selected seed for 10 years from twin ears. The stalks have become smaller but twin ears have increased without decrease in their size or quality.
70*	.....	Light loam.	8 cart loads manure. 400 lbs fertilizer.	.....
100*	....	.....	500 lbs. commercial fertilizer.	.....
100*	.....	.....	" " "	.....
60	7–8	Light loam.	6 cart loads manure per acre. 400 lbs. fertilizer. Cultivated twice, hoed once.	.....
50	8	.....	700 lbs. fertilizer per acre. Cultivated both ways twice.	Larger and somewhat later than formerly.
40	.....	Heavy loam.	.....	.....

* Ears.

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No.	Name of Variety.	Class.	Sender's Name and Residence.	No. years raised on same farm.	Date of planting.	Date of cutting.	Distance of hills in the row and between rows in feet.	Number of stalks in a hill.
80	Tolland Co. Premium.	Yellow flint.	N. R. Grant, Rockville.	---	May 20	Sept. 10	3½ × 3½	---
81	Improved Canada.	"	" " "	---	" 20	" 10	3½ × 3½	---
82	Doolittle.†	"	N. S. Platt, Cheshire.	100	.....	.....	.....	---
83	Chapman.	"	George F. King, Storrs.	12	May 20	Sept. 1	3 × 3½	---
84	Early Champion Improved.	"	John Babcock, So. Windham.	8	" 8	Aug. 25	3 × 3½	4
85	Yellow Cap.	"	Sherwood Raymond, Norwich.	12	" 25	Sept. 11	3½ × 3½	4
86	Flesh Colored.	Red flint.	N. R. Grant, Rockville.	---	" 20	" 10	3½ × 3½	---
87	Improved Dutton.	Yellow flint.	John Bishop, Cheshire.	12	" 10	" 15	3¾ × 3¾	3
88	Cross, Red Dent and Beers' Yellow.	Red flint.	N. S. Platt, Cheshire.	---	" 20	" 12	3¾ × 3¾	---
89	R. I. White Cap.	White flint.	C. W. Briggs, Lebanon.	5	" 20	Oct. 10	3 × 3½	4
90	Asher-Wright Corn.	Yellow flint.*	Edgar D. White, Andover.	25	June 8	Sept. 20	3 × 3½	3–5

* Slight indentations.

† Grown on the Doolittle farm, Cheshire, and by Doolittle family for over 100 years.

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Average yield of shelled corn in bushels.	Average height of stalks in feet.	Character of Soil.	Manure and Cultivation.	Remarks.
68	.....	Sandy loam.	30 cart loads manure. Cultivated and hoed twice.	.....
68	.....	" "	30 cart loads manure. Cultivated and hoed twice.	.....
135*	6	Light loam.	50 cart loads manure. Cultivated and hand-hoed twice.	.....
70	5½	Dark loam.	30 cart loads manure. Cultivated and hand-hoed twice.	Cross of Tolland Co. Yellow and Canada Yellow.
110*	6	.....	Stable manure. Fertilizer in hill.	.....
68	.....	Sandy loam.	30 cords manure. Cultivated and hoed twice.	.....
50	7	Sandy.	6 cords manure, 200 lbs. fertilizer. Cultivated 3 times, hoed once.	.....
40	.....	Heavy loam.	.....	.....
50	7½	Clay loam.	20 cart loads manure, 200 lbs. fertilizer. Cultivated 3 times, hoed twice.	.....
71	5–6	" "	20 cart loads manure. Cultivated and hoed twice.	.....

* Ears.

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No.	Weight of Kernel from one ear, grams.	Weight of Cob from one ear, grams.	Ratio of weight of Cob to Kernel.	Weight of one Ear, grams.	Number of rows of Kernels on the Ear.	Analysis.					
						Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract. (Starch, Gum, etc.)	Fat.
1	---	--	1 : 5.6	---	14–16	10.45	1.40	10.00	1.52	72.30	4.33
2	143	29	4.9	172	8	9.73	1.45	13.06	1.00	69.43	5.33
3	225	46	4.9	272	12–16	9.10	1.30	9.31	1.60	74.50	4.19
4	110	16	6.7	126	8	9.13	1.15	11 06	1.20	72.53	4.93
5	139	25	5.5	164	16–18	10.49	1.38	10.13	1.79	71.91	4.30
6[1]	131	22	5.8	154	8	9.57	1.10	10.25	1.35	72.35	5.38
6[2]	127	20	6.2	147	8	8.76	1.55	11.25	1.15	72.03	5.26
7	189	26	7.1	216	8	9.58	1.51	11.19	1.00	72.11	4.61
8	208	36	5.8	243	8	10.08	1.39	10.00	.88	73.09	4.56
9	99	16	6.4	114	8	12.60	1.41	9.12	.92	71.18	4.77
10	119	22	5.4	141	8	12.12	1.22	10.50	.94	69.60	5.62
11	162	31	5.2	193	8	11.76	1.39	9.81	.96	70.99	5.09
12	201	50	4.0	252	8	12.92	1.33	10.87	1.15	69.07	4.66
13	146	28	5.2	175	8	12.55	1.45	10.62	.85	69.78	4.75
14	247	--	--	---	20	12.62	1.15	8.81	1.22	71.07	5.13
15	254	47	5.5	300	12–14	14.68	1.79	10.06	1.06	68.26	4.15
16	190	40	4.8	230	8	12.98	1.65	10.44	1.11	68.68	5.14
17	187	35	5.4	222	12–14	9.77	1.39	9.31	1.49	73.40	4.64
18	147	34	4.3	186	8	10.80	1.30	10.93	.95	70.90	5.12
19	151	27	5.5	178	8	13.35	1.44	9.81	.95	69.61	4.84
20	135	24	5.6	159	8	12.55	1.46	9.06	.84	71.59	4.50
21	175	42	4.2	217	8–12	11.85	1.64	12.17	1.52	65.55	7.27
22	237	42	5.6	279	14–18	13.30	1.09	10.12	1.27	69.86	4.36
23	197	43	4.5	241	8	11.98	1.47	12.36	1.08	68.33	4.78
24	295	63	4.6	360	8	14.21	1.38	11.34	1 15	67.42	4.50
25	201	30	6.7	231	8	12.28	1.40	10.80	.80	69.68	5.04
26	208	46	4.5	255	8–10	11.32	1.24	9.78	1.02	72.42	4.22
27	251	55	4.6	305	12–16	11.77	1.58	11.53	1.37	69.43	4.32
28	217	44	5.0	261	12	11.15	1.60	10.99	1.68	70 69	3.89
29	313	70	4.5	383	16–22	13.40	1.12	10.75	1.84	68.39	4.50
30	158	36	4.4	194	8	11.43	1.11	9.97	.99	71.73	4.77
31	232	61	3.8	293	8	14.36	1.08	9.42	.98	69.62	4.54
32	172	32	5.4	204	12–16	12.63	1.00	8.94	1.25	72.12	4.06
33	202	52	3.9	254	8	12.05	1.41	9.48	1.38	71.17	4.51
34	172	38	4.5	210	8	11.68	1.10	10.17	1.21	70 88	4.96
35	155	22	7.0	177	8	11.51	1.26	10.26	.98	71.54	4.45
36	164	21	7.8	185	8	11.89	1.24	10.12	.75	71.33	4.67
37	157	34	4.6	191	8	11.16	.91	9.04	1.39	73.15	4.35
38	169	39	4.3	208	8–10	11.90	1.36	11.53	1.33	69.26	4.62
39	196	37	5.3	233	8–9	12.39	1.25	11.49	1.28	69.34	4.25
40	184	35	5.3	219	14	12.80	1.12	10.07	1.41	70.38	4.22
41	215	43	5.0	258	8	12 97	1.33	11.49	1.31	69.11	3.79
42	158	31	5.1	189	8–10	13.24	1.28	10 26	1.14	69.39	4.69
43	121	15	8.0	136	8	12.52	1.18	12.71	1.09	67.63	4.87
44	165	32	5.1	197	12	12.76	1.10	7.58	.91	72.96	4.69
45	151	27	5.6	178	8	12.61	1.22	10.95	1.15	69.57	4.50

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Analysis, Calculated Water-free.					Analysis, Calculated to Water Content of 14 per cent.					
Ash.	Protein.	Fiber.	Nitrogen-free Extract (starch, Gum, etc.)	Fat.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract (Starch, Gum, etc.)	Fat.
1.56	11.16	1.70	80.75	4.83	14.00	1.34	9.60	1.16	69.45	4.15
1.61	14.47	1.11	76.90	5.91	14.00	1.38	12.44	.95	66.15	5.08
1.43	10.24	1.76	81.96	4.61	14.00	1.23	8.81	1.52	70.48	3.96
1.26	12.17	1.32	79.83	5.42	14.00	1.08	10.47	1.12	68.67	4.66
1.54	11.33	1.99	80.33	4.81	14.00	1.32	9.75	1.71	69.09	4.13
1.22	11.34	1.49	80.00	5.95	14.00	1.05	9.76	1.29	68.78	5.12
1.70	12.33	1.26	78 95	5.76	14.00	1.46	10.60	1.08	67.91	4.95
1.67	12.38	1.11	79.74	5.10	14.00	1.43	10 65	.95	68.58	4.39
1.55	11.12	.98	81.28	5.07	14.00	1.33	9.56	.84	69.91	4.36
1.61	10.44	1.05	81.44	5.46	14.00	1.38	8.98	.91	70.03	4.70
1.39	11.95	1.07	79.20	6.39	14.00	1.19	10.27	.93	68.11	5.50
1.58	11.11	1.09	80 45	5.77	14.00	1.36	9.55	.94	69.19	4.96
1.53	12.48	1.32	79.34	5.33	14.00	1.31	10.75	1.12	68.24	4.58
1.66	12.14	.97	79.80	5.43	14.00	1.42	10.44	.83	68.63	4.68
1.32	10.08	1.40	81.33	5.87	14.00	1.12	8.67	1.20	69.97	5.04
2.10	11.79	1.24	80.00	4.87	14.00	1.81	10.14	1.06	68.80	4.19
1.90	11.99	1.28	78.92	5.91	14.00	1.63	10 31	1.10	67.88	5.08
1.54	10.32	1.65	81.35	5.14	14.00	1.32	8.89	1.41	69.95	4.43
1.46	12.25	1.06	79.49	5.74	14.00	1.26	10.55	.92	68.34	4.93
1.66	11.31	1.10	80.35	5.58	14.00	1.42	9.73	.95	69.10	4.80
1.67	10.37	.96	81.86	5.14	14.00	1.43	8.92	.82	70.40	4.43
1.86	13.75	1.72	74.45	8.22	14.00	1.60	11.83	1.48	64.03	7.06
1.24	11.66	1.45	80.63	5.02	14.00	1.06	10.03	1.25	69.34	4.32
1.67	14 04	1.22	77.63	5.44	14.00	1.43	12.07	1.05	66.77	4.68
1.61	13.22	1.33	78.59	5.25	14.00	1.38	11.37	1.13	67.60	4.52
1.60	12.30	.91	79.44	5.75	14.00	1.37	10.58	.78	68.33	4.94
1.39	11.03	1.15	81.67	4.76	14.00	1.19	9.48	.99	70.25	4.09
1.79	13.08	1.54	78.71	4.88	14.00	1.55	11.25	1.32	67.68	4.20
1.80	12.37	1.89	79.56	4.38	14.00	1.55	10.64	1.62	68.42	3.77
1.29	12.41	2.11	78.99	5.20	14.00	1.10	10.67	1.82	67.95	4.47
1.25	11.27	1.12	80.99	5.37	14.00	1.07	9.69	.96	69.66	4.62
1.27	11.00	1.15	81.32	5.26	14.00	1.09	9.46	.99	69.94	4.52
1.14	10 25	1.42	82.55	4.64	14.00	.98	8.82	1.22	70.99	3.99
1.60	10.78	1.58	80.91	5.13	14.00	1.37	9.27	1.36	69.59	4.41
1.24	11.52	1.36	80.26	5.62	14.00	1.06	9.91	1.16	69.04	4.83
1.42	11.59	1.11	80.86	5.02	14.00	1.22	9.97	.95	69.54	4.32
1.40	11.48	.85	80.97	5.30	14.00	1.20	9 87	.73	69.64	4.56
1.01	10.16	1.57	82.36	4.90	14.00	.87	8.74	1.35	70.83	4.21
1.54	13.09	1.50	78 63	5.24	14.00	1.32	11.26	1.29	67.62	4.51
1.42	13.11	1.46	79.16	4.85	14.00	1.22	11.27	1.26	68.08	4.17
1.28	11.54	1.62	80.72	4.84	14.00	1.10	9.92	1.39	69.43	4.16
1.53	13.20	1.50	79.41	4.36	14.00	1.31	11.35	1.29	68.30	3.75
1.48	11.84	1.30	79.98	5.40	14.00	1.28	10.18	1.11	68.79	4.64
1.34	14.53	1.23	77.33	5.57	14.00	1.14	12.49	1.05	66.53	4.79
1.26	8.69	1.03	83.64	5.38	14.00	1.08	7.47	.89	71.94	4.62
1.39	12.54	1.30	79.62	5.15	14.00	1.19	10.78	1.11	68.49	4.43

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No.	Weight of Kernel from one ear, grams.	Weight of Cob from one ear, grams.	Ratio of weight of Cob to Kernel.	Weight of one Ear, grams.	Number of rows of Kernels in the Ear.	Analysis.					
						Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract, (Starch, Gum, etc.)	Fat.
46	120	17	1 : 7.0	137	8	13.51	1.36	11.97	1.14	67.18	4.84
47	170	31	5.5	201	8–10	11.69	1.20	10.70	.90	70.46	5.05
48	191	28	6.8	219	12–18	12.53	1.22	10.26	1.40	70.82	3.77
49	246	30	8.2	276	16	12.04	1.09	9.73	1.25	71.05	4.84
50	123	24	5.1	147	8	12.45	1.01	9.22	.80	71.31	5.21
51	221	46	4.8	267	10–14	14.08	1.20	9.63	1.10	69.62	4.37
52	223	45	5.0	268	8	12.46	1.10	10.84	.86	69.70	5.04
53	264	53	5.0	317	14–16	11.19	1.20	9.27	1.21	72.38	4.75
54	208	48	4.3	256	12–14	14.23	1.35	10.80	1.20	67.84	4 58
55	227	42	5.4	269	8	15.39	1.25	9.37	.92	68.42	4.65
56	242	48	5.0	290	12–20	13.69	1.19	9.09	1.65	70.25	4.13
57	105	22	4.8	127	8	12.70	1.27	9.63	1.63	69.70	5 07
58	137	18	7.6	155	..	12.37	1.33	11.64	.86	68.58	5.22
59	122	21	5.8	143	8	12.98	1.26	10.45	.86	69.69	4.76
60	182	29	6.3	211	..	13.67	1.23	10.75	1.09	68.93	4.33
61	136	23	5.9	159	8	13.84	1.17	11.29	.98	67.80	4.92
62	156	40	3.9	196	8–10	12.33	1.39	10.99	1.44	70.16	3.69
63	183	23	8.0	206	14–20	11.88	1.13	9 73	1.37	72.09	3.80
64	192	35	5 5	227	14–20	12.63	1.40	8.84	1.30	73.08	2.75
65	199	34	5.9	233	8	11.31	1.10	10.60	.83	71.49	4.67
66	278	39	7.1	317	12–16	14.48	1.23	8.79	.95	70.27	4.28
67	192	47	4.1	239	10	12 67	1.20	9.22	1.39	72.42	3.10
68	223	50	4 5	273	8	14.38	1.28	10.02	.72	69.63	3.97
69	175	45	3.9	220	8	11.33	1.34	10.17	.94	71.85	4.37
70	164	38	4.3	202	8	11.64	1.16	10.99	.92	70.06	5.23
71	158	29	5.4	187	8	16.66	1.11	7.82	1.15	68.76	4.50
72	161	35	4.6	196	8	14.66	1.13	9.88	1.03	68.98	4 32
73	204	31	6.6	235	8	13.52	1.15	11.49	1.15	68 19	4.50
74	189	33	5.7	222	12	12.12	1.07	10.76	.80	70.00	5.25
75	178	36	4.9	214	10–12	12.50	1.10	10.35	1 00	70 91	4.14
76	92	15	6.1	107	8	12.42	1.05	8.10	1.32	72.54	4 57
77	206	31	6.6	237	12	12.46	.89	7.28	1.37	73.83	4.17
78	128	27	4.7	155	12	12.43	.80	10.00	1.02	70.67	5.08
79	222	45	5.0	267	8–10	12.97	.90	7.69	1.25	72.78	4.41
80	168	29	5.8	197	8	12.57	.93	10.00	.80	71.54	4.16
81	127	18	7.0	145	8	12.18	1.12	11.43	.85	70.19	4.23
82	247	46	5.4	293	8	12.60	1.07	10.25	.97	70.24	4.87
83	125	32	3.9	157	8	12.69	.97	11.02	1.02	69.30	5.00
84	110	23	4.8	133	8	12.72	.95	9.84	1.17	70.86	4.46
85	152	29	5.2	181	8	12.34	.94	11.53	.90	69.67	4.62
86	133	22	6.0	155	8	12.51	1.26	10.66	.85	69.57	5.15
87	169	48	3.5	217	12	12.77	1.02	9.12	.95	71.14	5.00
88	159	23	6.9	181	8–10	12.78	1.00	7.69	.82	72.97	4.74
89	136	25	5.4	161	8	12.34	.95	11.69	1.00	70.12	3.90
90	111	17	6.5	128	8	12.27	.88	11.28	.91	70.50	4.16

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Analysis, Calculated Water-free.					Analysis, Calculated to Water Content of 14 per cent.					
Ash.	Protein.	Fiber.	Nitrogen-free Extract (Starch, Gum, etc.)	Fat.	Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract (Starch, Gum, etc.)	Fat.
1.56	13.86	1.31	77.68	5.59	14.00	1.34	11.92	1.12	66.81	4.81
1.36	12.13	1.02	79.78	5.71	14.00	1.16	10.43	.88	68.62	4.91
1.39	11.75	1.60	80.98	4.28	14.00	1.19	10.10	1.37	69.66	3.68
1.23	11.06	1.41	80.80	5.50	14.00	1.05	9.51	1.21	69.50	4.73
1.15	10.42	.92	81.56	5.95	14.00	.99	8.96	.79	70.15	5.12
1.40	11.21	1.28	81.02	5.09	14.00	1.20	9.64	1.10	69.68	4.38
1.26	12.39	.98	79.62	5.75	14.00	1.08	10.65	.84	68.48	4.95
1.35	10.43	1.36	81.51	5.35	14.00	1.15	8.97	1.16	70.12	4.60
1.57	12.59	1.40	79.10	5.34	14.00	1.35	10 83	1.20	68.03	4.59
1.47	11.08	1.09	80.87	5.49	14.00	1.27	9.53	.94	69.54	4.72
1.38	10.52	1.90	81.42	4.78	14.00	1.18	9.05	1.63	70.03	4.11
1.46	11.03	1.86	79.86	5.79	14.00	1.26	9.48	1.60	68.68	4.98
1.51	13.28	.98	78.28	5.95	14.00	1.30	11.42	.84	67.32	5.12
1.45	12.00	.98	80.11	5.46	14.00	1.25	10.32	.84	68.70	4.69
1.42	12.44	1.25	79.88	5.01	14.00	1.22	10.70	1.07	68.71	4.30
1.36	13.09	1.14	78.71	5.70	14.00	1.16	11.26	.98	67.70	4.90
1.58	12.53	1.63	80.05	4.21	14.00	1.36	10.77	1.40	68.85	3.62
1.28	11.05	1.55	81.81	4 31	14.00	1.10	9.50	1.33	70.36	3.71
1.60	10.11	1.48	83.66	3.15	14.00	1.37	8.69	1.28	71.95	2.71
1.24	11.95	.93	80.63	5.25	14.00	1.06	10.28	.80	69.35	4.51
1.43	10.27	1.12	82.17	5.01	14.00	1.23	8.84	.96	70.67	4.30
1.37	10.56	1.60	82.92	3.55	14.00	1.17	9.08	1.37	71.33	3.05
1.50	11.70	.84	81.32	4.64	14.00	1.29	10.06	.72	69.94	3.99
1.50	11.46	1.06	81.05	4.93	14.00	1.29	9.85	.92	69.70	4.24
1.30	12.43	1.16	79.26	5.85	14.00	1.11	10.69	1.00	68.17	5.03
1.33	9.38	1.37	82.52	5.40	14.00	1.13	8.07	1.17	70.99	4.64
1.32	11.59	1.20	80.83	5.06	14.00	1.12	9.97	1.03	69.57	4.35
1.32	13.29	1.32	78.87	5.20	14.00	1.12	11.43	1.12	67.86	4.47
1.22	12.24	.91	79.66	5.97	14.00	1.06	10.52	.78	68.51	5.13
1.26	11.83	1.14	81.04	4.73	14.00	1.10	10.17	.99	69.67	4.07
1.20	9.25	1.51	82.82	5.22	14.00	1.04	7.96	1.30	71.21	4.49
.98	8.33	1.56	84.37	4.76	14.00	.84	7.16	1.35	72.56	4.09
.91	11.41	1.17	80.71	5.80	14.00	.78	9.80	1.02	69.41	4.99
1.04	8.82	1.44	83.63	5.07	14.00	.90	7.59	1.25	71.90	4.36
1.06	11.44	.91	81.83	4.76	14.00	.92	9.83	.78	70.38	4.09
1.28	13.02	.97	79.91	4.82	14.00	1.10	11.19	.83	68.74	4.14
1.22	11.72	1.11	80.38	5 57	14.00	1.06	10.08	.96	69.11	4.79
1.11	12.62	1.17	79.37	5.73	14.00	.96	10.86	1.01	68.24	4.93
1.09	11.32	1.34	81.14	5.11	14.00	.94	9.74	1.16	69.76	4.40
1.07	13.14	1.03	79.49	5.27	14.00	.92	11.30	.89	68.36	4.53
1.44	12.19	.97	79.51	5.81	14.00	1.25	10.49	.83	68.37	5.06
1.16	10.46	1.05	81.61	5.72	14.00	1.01	9.00	.91	70.16	4 92
1.15	8.79	.91	83.72	5.43	14.00	1.00	7.56	.78	71.98	4.68
1.08	13.33	1.14	80.01	4.44	14.00	.93	11.47	.99	68.79	3.82
1.00	12.86	1.05	80.35	4.74	14.00	.86	11.06	.91	69 10	4.07

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STATE OF CONNECTICUT

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EIGHTEENTH ANNUAL REPORT

— OF —

The Connecticut Agricultural Experiment Station

For 1894

Printed by Order of the General Assembly

The publications of this Station are sent free to every citizen of Connecticut who applies for them. Address, The Conn. Agricultural Experiment Station, New Haven, Conn.

NEW HAVEN:
THE TUTTLE, MOREHOUSE & TAYLOR PRESS
1895

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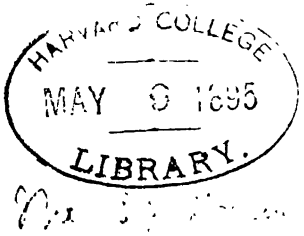

CORRECTIONS.

The Index to the Report of this Station for 1893 is defective under the letter V, p. 331.

Following is the corrected index for that letter:—

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The following corrections are to be made in the Report of 1894.

Page 6. At the beginning of the list of manufacturers who have complied with the fertilizer law, insert: G. B. Alderman, Suffield, Special Potato Fertilizer.

Page 45. Eighth line from the bottom, erase the words: "as muriate." The sample 4480 of Shoemaker's Swift-Sure Superphosphate, as shown by the analysis on page 89, contains 3.88 per cent. of potash calculated as sulphate and .59 per cent. calculated as muriate.

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OFFICERS AND STAFF FOR 1894.

STATE BOARD OF CONTROL.

Ex-officio.

His Excellency LUZON B. MORRIS, *President.*

	Term expires,
Appointed by Connecticut State Agricultural Society:	
Hon. E. H. HYDE, Stafford, *Vice-President.*	July 1, 1897
Appointed by Board of Trustees of Wesleyan University:	
Prof. W. O. ATWATER, Middletown.	1897
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1895
JAMES H. WEBB, Hamden.	1896
Appointed by Board of Agriculture:	
T. S. GOLD, West Cornwall.	1895
Appointed by Governing Board of Sheffield Scientific School:	
W. H. BREWER, New Haven, *Secretary and Treasurer.*	1896
Ex-officio.	
S. W. JOHNSON, New Haven, *Director.*	

Executive Committee.

Station Staff.

Chemists.

S. W. JOHNSON, *Director.*
E. H. JENKINS, Ph.D., *Vice-Dir.*
A. L. WINTON, Ph.B.
T. B. OSBORNE, Ph.D.
A. W. OGDEN, Ph.B.
W. R. JOHNSTON, Ph.B.*
G. F. CAMPBELL, Ph.B.†

Mycologist.

WILLIAM C. STURGIS, Ph.D.

Horticulturist.

W. E. BRITTON, B.S.

Grass Gardener.

JAMES B. OLCOTT, South Manchester.

Stenographer and Clerk.

Miss C. S. GREEN.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helpers.

HUGO LANGE. JULIUS KORN.

Sampling Agents.

DENNIS FENN, Milford. M. H. PARKER, So. Coventry.

* Till Aug. 1. † From Oct. 15.

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Notice as to Bulletins.

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to others, as far as the limited editions permit.

Applications should be renewed annually before January 1st.

The matter of all the Bulletins of this Station, in so far as it is new or of permanent value, will be made part of the Annual Report of the Director.

Bulletins earlier than No. 71 and Nos. 83, 93, 100, 101, 102, 106, 109, 111 and 118, are exhausted and cannot be supplied.

Notice as to Supply of Station Reports.

The Station has no supply of its Annual Reports for the years 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1887, 1891, and 1893.

The Annual Report of this Station, printed at State expense, is by law limited to an edition of 12,000 copies, of which 5,000 copies are bound with the Annual Report of the Connecticut State Board of Agriculture, and distributed by the Secretary of the Board, T. S. Gold, West Cornwall, Conn.

After exchanging with other Experiment Stations and Agricultural Journals, the Reports remaining at the disposal of the Station will be sent to Citizens of Connecticut who shall seasonably apply for them, and to others as long as the supply lasts.

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ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, moulds, blights, mildews, useful or injurious insects, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station does not undertake sanitary analyses of water.

The Station makes analyses of Fertilizers, Seed-Tests, etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.

2. That the samples are taken from stock now in the market, and in accordance with the Station "Instructions for Sampling."

3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs, and like Associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the private use of individuals is charged for at moderate rates. The Station undertakes no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of immediate general interest are published in Bulletins, copies of which are sent to each Post Office in this State, and to every citizen of the State who applies for them. The results of all the work of the Station are summed up in the Annual Reports made to the Governor.

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It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention should be *prepaid.*

☞ Letters sent to individual officers are liable to remain unanswered in case the officer addressed is absent. All communications therefore should be directed simply to the

AGRICULTURAL EXPERIMENT STATION,

NEW HAVEN, CONN.

☞ Station Grounds, Laboratories and Office are on Suburban st., between Whitney avenue and Prospect st., 1½ miles north of City Hall. Suburban st. may be reached by Whitney ave. electric cars, which leave the corner of Chapel and Church sts. four times hourly, viz: on the striking of the clock and at intervals of fifteen minutes thereafter.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 118 Court st., or from Peck & Bishop's Office in Union R. R. Depot.

☞ The Grass Garden, in charge of Mr. James B. Olcott, is near South Manchester and may be reached by A. Gardner's regular Passenger Express starting at 9 A. M. and 1 P. M. from Cheney's Store, So. Manchester, or starting at 10 A. M. and 4 P. M. from Burnside, where connection is made by electric car with Hartford.

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REPORT OF THE TREASURER.

WM. H. BREWER, IN ACCOUNT WITH THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION FOR THE FISCAL YEAR ENDING SEPTEMBER 30TH, 1894.

RECEIPTS.

	Oct. 1893 to June 1894	July to Sept. 1894.	Total.
State Appropriation	$6,000.00	$2,000 00	$8,000.00
United Statos Appropriation	5,625 00	1,875.00	7,500.00
Analysis Fees due last year rec'd this year	231.89	80.00	311.89
Analysis Fees of this year	4,510.00	157.04	4,667.04
Miscellaneous Receipts	374.55	8.40	382.95
Total Receipts	$16,741.44	$4,120.44	$20,861.88

EXPENDITURES.

	State Acc't	U. S. Acc't.	Total.
Salaries*	$4,839.50	$4,950.00	$9,789.50
" †	1,307.50	1,825.00	3,132.50
Labor†	88.75	.....	88.75
Publications*	170.35	134.22	304.57
" †	5.44	.....	5.44
Postage*	66.78	.....	66.78
" †	60.18	.....	60.18
Stationery*	96.42	.....	96.42
" †	16.32	.....	16.32
Freight and Express†	11.79	.....	11.79
Coal*	13.00	.....	13.00
" †	547.25	.....	547.25
Gas†	230.85	.....	230.85
" †	34.20	.....	34.20
Water*	147.00	.....	147.00
Laboratory Expenses*	1,459.36	29.74	1,489.10
Chemicals†	6.20	32.38	38.58
Laboratory Supplies†	15.77	.....	15.77
Field Experiments*	.....	50.58	50.58
" " †	20.00	.....	20.00
Tobacco Experiments*	175.69	.....	175.69
" " †	267.87	.....	267.87
Dairy Tests*	.....	52.51	52.51
Grass Garden*	200.00	400.00	600.00
" " †	200.00	.....	200.00
Turf Collection†	500.00	.....	500.00
Mycological Expenses*	19.57	7.95	27.52
Miscellaneous Supplies†	61.78	.....	61.78

* For the 9 months, Oct, 1893 to June, 1894, inclusive.
† For the 3 months, July to September, 1894, inclusive.

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	State Acc't.	U. S. Acc't.	Total.
Fertilizers†	----------	$17.62	$17.62
Feeding Stuffs†	$23.15	----------	23.15
Library*	287.14	----------	287.14
" †	37.80	----------	37.80
Tools and Machinery†	58.90	----------	58.90
Office Supplies*	59.42	----------	59.42
Furniture†	34.05	----------	34.05
Scientific Apparatus†	35.95	----------	35.95
Traveling Expenses of the Board*	7.51	----------	7.51
" " " " †	22.69	----------	22.69
" " of the Staff†	100.58	----------	100.58
Unclassified Sundries*	299.45	----------	299.45
Contingent Expenses†	3.85	----------	3.85
Telephone*	75.25	----------	75.25
" †	25.25	----------	25.25
Collecting Fertilizers*	320.13	----------	320.13
Insurance*	67.50	----------	67.50
The Establishment Growers, Repairs, etc.*	322.37	----------	322.37
New Greenhouse*	495.52	----------	495.52
" " †	373.54	----------	373.54
Improvement on Buildings†	64.02	----------	64.02
Repairs†	68.11	----------	68.11
	$13,343.75	$7,500.00	$20.843.75
Balance to New Account			18.13
			$20,861.88

The accounts of the treasurer were duly audited December 11th, 1894 by the State Auditors of Public Account.

As in previous years the Analysis Fees of fertilizers known to have been on sale after May 1st and subject to the law concerning commercial fertilizers, coming into the hands of the treasurer after closing the above account, will be credited to the next year's account.

Beginning with July 1st, 1894, all the Agricultural Experiment Stations receiving appropriations from the United States are required to make their treasurer's reports to the Secretary of Agriculture of the United States instead of to the Secretary of the Treasury as heretofore. Said reports must hereafter be made in accordance with schedules prepared by the Department of Agriculture and for the fiscal year used by the general Government.

The treasurer of this station will hereafter be required to make reports for two different fiscal years, that of the United States which ends June 30th, and that of the State which ends Sept. 30th. I have therefore prepared this report for our State fiscal year giving the amounts for nine and three months respectively, that its agreement with that to be made to the Secretary of Agriculture next year may be obvious.

WM. H. BREWER, *Treasurer.*

* For the 9 months, Oct., 1893 to June, 1894, inclusive.
† For the 3 months, July to September, 1894, inclusive.

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REPORT OF THE BOARD OF CONTROL.

To his Excellency, Luzon B. Morris, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station, herewith submits its report for the year ending October 31st, 1894.

In executing the provisions of the State Fertilizer Law, Messrs. Dennis Fenn and M. H. Parker the agents of this Station have visited seventy-eight towns and villages and have drawn four hundred and fifty-six samples, representing one hundred and fifty-six distinct brands of commercial fertilizers.

In the chemical laboratory of the Station, Messrs. Winton and Ogden, with the aid of Mr. Lange, have made three hundred and thirty-one analyses of commercial fertilizers, manures and manurial waste-products. The results of these analyses have been prepared for publication by Dr. Jenkins, are now in the printer's hands and with other appropriate matter will form Part I of the Eighteenth Annual Report.

In continuation of work begun at this Station in 1885—on the relative availability to growing plants of the various forms of organic nitrogen found in fertilizers and on proposed methods for estimating this availability there have been made this year, one hundred and fifty vegetation experiments, for which Indian corn was grown in pots of artificial soil and supplied with nitrogen from different fertilizers whose relative value as regards their nitrogen, it was thus sought to determine. Eleven articles representing the materials most used in the fertilizer manufacture, were also examined with respect to the solubility of their nitrogen in pepsin solution and under putrefaction. These investigations taken together, furnish a comparison of the three methods of estimating the availability of organic nitrogen.

This investigation is the joint work of the Director and Vice-Director aided by Messrs. Britton, Winton, Ogden and Lange.

A considerable number of feeding stuffs have been analyzed in behalf of purchasers.

On behalf of the State Dairy Commissioner twenty-three samples

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of suspected butter and five samples of molasses have been tested by Dr. Jenkins, and in twelve cases expert evidence has been furnished by him in court.

More than two hundred samples of milk and cream have been chemically examined, chiefly to determine butter-fat.

Eighteen nearly complete analyses of milk have been made at the request of milk dealers and the fact of adulteration established in several of the samples.

An extended study has been made of the method of paying for cream, which is at present most commonly used in this State, and of the arrangements which creameries must make in order to adopt the more equitable system of paying patrons according to the butter-fat contained in the cream, as determined by the Babcock test. On request of creamery superintendents, eleven creameries have been visited, in some cases a considerable number of times, to explain and illustrate the working of the new system in all particulars, from the sampling of the cream by the cream-gatherer, to the final monthly calculation of payments and incidentally several hundred tests of milk and cream have been made at the creameries.

As a result of this work, six cream-gathering and two milk-gathering creameries have adopted and are now successfully using the system of payment just referred to.

All this work on feeding stuffs, milk and cream, has been most efficiently performed by Messrs. Winton and Ogden.

The work of Dr. W. C. Sturgis, Mycologist, may be briefly summarized as follows:

A critical study has been made in both the botanical laboratory and the field of the so-called "Early blight" of potatoes.

The value of the treatment of seed potatoes with corrosive sublimate solution just previous to planting, for the prevention of Potato Scab, has been tested in coöperation with Mr. Walter H. Olcott in a field experiment at South Manchester.

Experiments on the treatment of the Pear "Scab" in the orchard of Mr. A. E. Plant, of Branford, begun two years ago, have been continued this year.

The bacterial disease known as "fire blight," which does very considerable damage in this State, has been studied in the botanical laboratory.

Some work has also been done, as opportunity presented, upon other plant diseases, chiefly those of the peach, apple and quince.

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During the year Dr. Osborne has carried his investigations on the proteids contained in the seeds of Rye and Barley as far as is practicable at present, and the results of these studies are now ready for publication. He has also made good progress in an investigation of Diastase, that ferment of the cereal grains which transforms starch into sugar, and his preliminary paper on this subject is now ready to be printed. In this work he has been assisted by Mr. Johnston and Mr. Campbell.

The field-work of the Station except as already noted has been in the charge of the Vice-Director, as follows:—

The field experiment on the continuous growth of maize on the same land, begun in 1888, has been carried on this year as before at the farm of Mr. J. H. Webb, of Hamden.

In coöperation with Messrs. S. D. Woodruff & Sons, of Orange, a field experiment has been conducted for testing the effect of nitrate of soda in forcing the tomato crop, but owing to the dry weather has given no results.

The field experiments on the influence of different fertilizers on quality and quantity of the tobacco crop, have been prosecuted on the same plan as last year, in conjunction with the Connecticut Tobacco Experiment Co., at Poquonock.

With the coöperation of Prof. Milton Whitney, formerly of this Station and now Chief of the Division of Agricultural Soils, U. S. Department of Agriculture (which furnished the appropriate meteorological instruments), observations of rainfall, maximum and minimum soil-temperatures and maximum and minimum air-temperatures (by radiation thermometers), were daily made at the Poquonock Tobacco Station. Moisture was also determined in samples of soil taken on five different plots of the tobacco field each day from the time the tobacco plants were set till they were harvested. These samples securely packed, were daily sent by mail to New Haven for this examination which was made by Dr. Jenkins.

In the spring of 1894, a vegetation house, twenty-seven feet long by nineteen wide, was built on the Station grounds, with special reference to experiments on the growth of plants in pots during the summer season. Its construction and uses will be described on subsequent pages.

A forcing house, forty feet long by sixteen feet wide, has just been finished, to be used for experiments with fertilizers applied to winter crops, under glass.

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On seventeen days, one or two and sometimes three of the Station Staff have been engaged in attendance at meetings of Granges, Farmers' Institutes, and various other public gatherings of dairymen, orchardists, etc. where they demonstrated the Babcock milk-test, gave addresses and answered questions.

Three Bulletins have been issued during the year, containing in the aggregate seventy octavo pages.

Bulletin No. 118, on the "Literature of Fungous Diseases; a Provisional Bibliography, etc.," by Dr. W. C. Sturgis, issued in March 1894, was made a part of the 17th Annual Report as its preparation had been mostly accomplished during or before the time covered by that Report, and to save the very considerable expense of reprinting.

Bulletin No. 117 on "The Babcock method of determining fat in milk and milk products," published in January, and Bulletin No. 119, on "The Babcock Test as a basis for Payment in Cream-gathering Creameries," issued in May last, have been rewritten to include the results of further work and form part of this Annual Report.

The Station Staff has been increased during the year, by the appointment of a horticulturist. Mr. W. E. Britton, a graduate of the New Hampshire Agricultural and Mechanical College, and a graduate student of horticulture in Cornell University, entered on the duties of this position, on the first of May, 1894.

Mr. W. R. Johnston left the station on the first of August. The place thus made vacant was filled on the fifteenth of October, by Mr. George F. Campbell.

A detailed account of the investigations above referred to, will be found in the Reports of the Station Staff, which are now in preparation.

All of which is respectfully submitted.

WM. H. BREWER, *Secretary.*

New Haven, Conn., November 1st, 1894.

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REPORT OF STATION WORK.

A general statement of the lines of work followed by the Station Staff during the past year and of the results attained is to be found on previous pages, in the Report of the Board of Control.

The following pages present a full and detailed account of the operations of the Station within the twelvemonth ending October 31, 1894.

In the discussion of commercial fertilizers it is found advisable to reprint, annually, certain statements regarding the fertilizer law and the analysis and valuation of fertilizers, to answer questions which are constantly addressed to the Station on these subjects.

THE FERTILIZER LAW OF CONNECTICUT.

The General Assembly at its Session in 1893 passed an act, Chapter CLXXII, amending the fertilizer law previously in force in Connecticut.

The attention of all concerned is called to the following copy of the General Statutes of the State regarding fertilizers which embodies the amendments and is the law now in force.

Copies of the law may be had on application to the Station. Attention is specially called to the following requirements.

1. In case of *all* fertilizers or manures, except stable manure and the products of local manufacturers of less value than ten dollars a ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER has provided labels or statements and has paid the fee. Sections 4005 and 4007.

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The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, and which are generally Nitrogen, Phosphoric acid and Potash. The analysis-fees in case of any fertilizer will therefore usually be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, *in the case of every commercial fertilizer*, that a *sealed sample* shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him, Section 4006.

A statement of the per cent. of Nitrogen, Phosphoric Acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients: Nitrogen and Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide): that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price*, shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4008.

4. All "CHEMICALS" that are applied to land, such as Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Lime (Gypsum or Land Plaster), Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 4013 of the Act.

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It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 4013, that all fertilizers be analyzed and it requires the parties making or selling them to pay for these analyses in part: the State itself paying in part by maintaining the Experiment Station.

ACTS CONCERNING COMMERCIAL FERTILIZERS.

Chapter CCLIII of the General Statutes of Connecticut as amended by Chapter CLXXII of the Acts of the General Assembly, Session of 1893.

SECTION 4005. Every person or company who shall sell, offer, or expose for sale, in this State, any commercial fertilizer or manure except stable manure, and the products of local manufacturers of less value than ten dollars a ton, shall affix conspicuously to every package thereof a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trade-mark under which the fertilizer is sold, the name and address of the manufacturer, the place of manufacture and the chemical composition of the fertilizer, expressed in the terms and manner approved and usually employed by the Connecticut Agricultural Experiment Station.

If any such fertilizer be sold in bulk, such printed statement shall accompany every lot and parcel sold, offered, or exposed for sale.

SEC. 4006. Before any commercial fertilizer is sold, offered, or exposed for sale, the manufacturer, importer, or person who causes it to be sold, or offered for sale, within this State shall file with the director of the Connecticut Agricultural Experiment Station two certified copies of the statement prescribed in section 4005, and shall deposit with said director a sealed glass jar or bottle containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SEC. 4007. The manufacturer, importer, agent, or seller of any commercial fertilizer shall pay on or before May 1, annually, to the director of the Connecticut Agricultural Experiment Sta-

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tion, an analysis fee of ten dollars for each of the fertilizing ingredients contained or claimed to exist in said fertilizer: *provided*, that when the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee prescribed in this section.

SEC. 4008. Every person in this State who sells, or acts as local agent for the sale of any commercial fertilizer of whatever kind or price, shall annually, or at the time of becoming such seller or agent, report to the director of the Connecticut Agricultural Experiment Station his name and brand of said fertilizer, with the name and address of the manufacturer, importer, or party from whom such fertilizer was obtained, and shall, on demand of the director of the Connecticut Agricultural Experiment Station, deliver to said director a sample suitable for analysis of any such fertilizer or manure then and there sold or offered for sale by said seller or agent.

SEC. 4009. No person or party shall sell, offer, or expose for sale, in this state any pulverized leather, raw, steamed, roasted, or in any form, as a fertilizer or as an ingredient of any fertilizer or manure, without explicit printed certificate of the fact, such certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany every parcel or lot of the same.

SEC. 4010. Every manufacturer of fish guano, or fertilizers of which the principal ingredient is fish or fish-mass from which the oil has been extracted, shall, before manufacturing or heating the same, and within thirty-six hours from the time such fish or mass has been delivered to him, treat the same with sulphuric acid or other chemical, approved by the director of said experiment station, in such quantity as to arrest decomposition: *provided, however*, that in lieu of such treatment such manufacturers may provide a means for consuming all smoke and vapors arising from such fertilizers during the process of manufacture.

SEC. 4011. Any person violating any provision of the foregoing sections of this chapter shall be fined one hundred dollars for the first offence, and two hundred dollars for each subsequent violation.

SEC. 4012. This chapter shall not affect parties manufacturing, importing, or purchasing fertilizers for their own private use, and not to sell in this State.

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SEC. 4013. The director of the Connecticut Agricultural Experiment Station shall pay the analysis-fees received by him into the treasury of the station, and shall cause one or more analyses of each fertilizer to be made and published annually. Said director is hereby authorized, in person or by deputy, to take samples for analysis from any lot or package of manure or fertilizer which may be in the possession of any dealer.

SEC. 4014. The director of the Connecticut Agricultural Experiment Station shall, from time to time, as bulletins of said station may be issued, mail or cause to be mailed two copies, at least, of such bulletins to each post-office in the State.

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OBSERVANCE OF THE FERTILIZER LAW.

Here follows an alphabetical list of the MANUFACTURERS who have paid Analysis Fees as required by the Fertilizer Law, and the names or brands of the Fertilizers for which Fees have been paid by them for the year ending May, 1895.

Firm.	*Brand of Fertilizer.*
Armour Packing Co., Kansas City, Mo.	Fine Ground Beef Bone. Fruit, Vegetable and Tobacco Special.
Baker, H. J. & Bro., 93 William St., New York City.	Tobacco Manure. Onion Manure. Potato Manure. Corn Manure. A. A. Ammoniated Superphosphate. Harvest Home Phosphate. Castor Pomace. Pure Ground Raw Bone.
Bowker Fertilizer Co., 43 Chatham St, Boston, Mass.	Stockbridge Special Tobacco Manure. " " Grain Manure. " " Grass Top-Dressing and Forage Crop Manure. Stockbridge Special Potato and Vegetable Manure. Bowker's Hill and Drill Phosphate. " Farm and Garden Phosphate or Ammoniated Bone Fertilizer. " Potato Manure. " Tobacco Grower. " Sure Crop Bone Phosphate.
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Bradley's Superphosphate. " Potato Manure. " Complete Manure for Potatoes and Vegetables. " Complete Manure for Top Dressing Grass and Grain. " Complete Manure for Corn and Grain. " Pure Fine Ground Bone. " Circle Brand Ground Bone and Potash. " Fish and Potash, Anchor Brand. " Fish and Potash, Triangle A Brand. " B. D. Sea Fowl Guano. " Original Coe's Superphosphate. " Farmer's New Method Fertilizer. " High Grade Tobacco Manure. "
Buckingham, C., Southport, Conn.	A No. 1 Fertilizer.
Chicopee Guano Co., 140 Maiden Lane, New York City.	Chicopee Potato Manure. Farmer's Reliable

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Firm.	*Brand of Fertilizer.*
Clark's Cove Fertilizer Co., Farlow Building, State St., Boston, Mass.	Great Planet "A." King Philip Guano. Potato and Tobacco Fertilizer. Bay State Fertilizer. Bay State Fertilizer G. G.
Cleveland Linseed Oil Co., Cleveland, Ohio.	Connecticut Wrapper Fertilizer, "Pinney Formula."
Coe Co.. The E. Frank, 133–135 Front St., New York City.	High Grade Potato Fertilizer. High Grade Ammoniated Superphosphate. Ground Bone and Potash. Special Tobacco Fertilizer, N. E. Brand. Gold Brand Excelsior. Fish and Potash. Alkaline Bone.
Cooper's Glue Factory, Peter, 17 Burling Slip, New York City.	Bone Dust.
Crocker Fertilizer and Chemical Co., Buffalo, New York.	Crocker's Ammoniated Bone Superphosphate. " Potato, Hop and Tobacco Phosphate. " Special Conn. Tobacco Manure. " Pure Ground Bone. " Ground Bone Meal. " New Rival Ammoniated Bone Superphosphate. " Vegetable Bone Superphosphate. " Ammoniated Wheat and Corn Phosphate. " Ammoniated Practical Superphosphate. " Special Potato Manure.
Cumberland Bone Phosphate Co., Boston, Mass.	Cumberland Superphosphate. " Potato Fertilizer.
Danbury Fertilizer Co., Danbury, Conn.	Bone Meal. Nameless Fertilizer. Potato Manure.
Darling Fertilizer Co.. The L. B, Pawtucket, R. I.	Darling's Wheat and Corn Fertilizer. " Animal Fertilizer. " Fine Ground Bone. " Extra Bone Phosphate. " Potato and Root Crop Manure. " Tobacco Grower.
Downes & Griffin, Birmingham, Conn.	Ground Bone.
Ellsworth, F., Hartford, Conn.	Shoemaker's Swift Sure Superphosphate. " " " Bone Meal. Collier Castor Pomace.

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Firm.	*Brand of Fertilizer.*
Frisbee Co., L. F., Hartford, Conn.	Bone Meal.
Great Eastern Fertilizer Co., Rutland, Vermont.	Great Eastern General Fertilizer for Grass and Grain. Great Eastern Vegetable, Vine and Tobacco. Great Eastern General for Oats, Buckwheat and Seeding down. Great Eastern General Soluble Bone and Potash Fertilizer.
Kelsey, E. R., Branford, Conn.	Bone, Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Celebrated Ground Bone. Ammoniated Dissolved Bone. Potato Fertilizer. Standard Superphosphate. Success Fertilizer.
Mapes Formula and Peruvian Guano Co., 143 Liberty, St., New York City.	Complete Manure for Light Soils. " " " General Use. " " "A" Brand. Potato Manure. Tobacco Starter. Fruit and Vine Manure. Grass and Grain Spring Top Dressing. Corn Manure. Fine Dissolved Bone. Tobacco Manure, Wrapper Brand.
Miller, Geo. W., Middlefield, Conn.	Ground Bone. Flour of Bone Phosphate.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Complete Fertilizer. " Ammoniated Bone Phosphate. " Fish and Potash. " Ground Bone.
Nuhn, Frederick, Waterbury, Conn.	Self-Recommending Fertilizer.
Olds & Whipple, Hartford, Conn.	Red Seal Castor Pomace. O. & W. Special Phosphate.
Peck Bros., Northfield, Conn.	Pure Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Ground Bone.
Preston Fertilizer Co., Greenpoint, L. I.	Onion Fertilizer. Potato Fertilizer. Ammoniated Bone Superphosphate.
Quinnipiack Rendering Co., Meriden, Conn.	Pure Ground Bone.

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Firm.	*Brand of Fertilizer.*
Quinnipiac Co., 92 State St., Boston, Mass.	Quinnipiac Phosphate. " Potato Manure. " Market Garden Manure. " Ammoniated Dissolved Bone. " Fish and Potash, Crossed Fishes Brand. " Fish and Potash, Plain Brand. " Pine Island Phosphate. " Havana Tobacco Fertilizer. " Grass Fertilizer. " Corn Manure. " Bone Meal. " Dry Ground Fish. Tankage. Muriate of Potash. Sulphate of Potash. Nitrate of Soda. Sulphate of Ammonia. Dissolved Bone Black.
Read Fertilizer Co., Box 3121, New York City.	Read's Standard. High Grade Farmer's Friend. Fish and Potash. Vegetable and Vine.
Reese, J. S. & Co., Baltimore, Md.	Reese's Potato Special. " New England Favorite.
Rogers & Hubbard Co., Middletown, Conn.	Pure Ground Raw Knuckle Bone Flour. Pure Ground Raw Knuckle Bone Meal. Strictly Pure Fine Bone. Fertilizer for Oats and Top Dressing. Soluble Potato Manure. Soluble Tobacco Manure. Grass and Grain Fertilizer. Fairchild's Formula for Corn and General Crops.
Rogers Mfg. Co., Rockfall, Conn.	Pure Ground Bone. Grass and Grain Fertilizer. Soluble Potato and General Crops. High Grade Fertilizer for Oats and Top Dressing. Complete Fertilizer. High Grade Corn Fertilizer.
Sanderson, L., New Haven, Conn.	Old Reliable Superphosphate. Formula A. (Complete). Pulverized Bone and Meat. Blood, Bone and Meat. Fine Ground Bone. Muriate of Potash. High Grade Sulphate of Potash. Regular Sulphate of Potash. Nitrate of Soda. Sulphate of Ammonia. Dissolved Bone Black.

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Firm.	*Brand of Fertilizer.*
Soluble Pacific Guano Co., Boston, Mass.	Pacific Guano. Potato Manure. High Grade General Fertilizer.
Standard Fertilizer Co., Farlow Building, State St., Boston, Mass.	Standard Superphosphate. Standard Complete Manure. Standard Potato and Tobacco Fertilizer.
Walker, Stratman & Co., Pittsburgh, Pa.	Potato Special. Tobacco Special. Banner Fertilizer. Four Fold Fertilizer.
Walton & Whann Co., Wilmington, Delaware.	Diamond Soluble Bone and Potash. Peerless Potato Manure.
Wheeler, M. E. & Co., Rutland, Vermont.	Potato Manure. Corn Fertilizer. Electrical Dissolved Bone. Grass and Oats Fertilizer.
Wilcox, Leander, Mystic, Conn.	Potato, Onion and Tobacco Manure. Ammoniated Bone Phosphate. Complete Bone Superphosphate. High Grade Fish and Potash.
Wilkinson & Co., 54 William St., New York City.	Economical Bone Fertilizer.
Williams & Clark Fertilizer Co., 81 Fulton St., New York City.	Americus Ammoniated Bone Superphosphate. " Potato Phosphate. " High Grade Special. " Pure Bone Meal. " Fine Wrapper Tobacco Grower. " Corn Phosphate. " Potato and Tobacco Fertilizer. " Grass Manure. " Fish and Potash. Royal Bone Phosphate.

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COLLECTION AND SAMPLING OF FERTILIZERS.

During the year 310 samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given on page 18.

On a few of these samples analyses were made for private parties and charged for accordingly. A few samples also were analyzed at request of other Experiment Stations in order to compare and test analytical methods. Results of the examination of all the samples, with these exceptions, are given in detail in the following pages.

During April, May and June, Messrs. Dennis Fenn of Milford, and M. H. Parker of South Coventry agents of this Station, visited seventy-eight towns and villages in Connecticut and drew 456 samples representing 166 distinct brands of commercial fertilizers.

In this way one or more samples were secured of nearly every brand of fertilizer which is offered for sale within the State. When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agents are instructed in every case to open at least three packages of each brand for sampling, and if the number of packages is large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

As a rule, the Station will not analyze samples—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs, and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. All samples drawn by other than Station agents *must be drawn in strict accordance with the Station's Instructions for Sampling, and must*

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also be properly certified, if the Station analysis is desired. A copy of these Instructions and blank Certificates will be sent on application.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for explanation or protest, before the results are published.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

EXPLANATIONS CONCERNING THE ANALYSIS OF FERTILIZERS AND THE VALUATION OF THEIR ACTIVE INGREDIENTS.*

The Elements of Fertilizers.

The three chemical elements whose compounds chiefly give value, both commercial and agricultural, to fertilizers are Nitrogen, Phosphorus and Potassium. The other elements found in fertilizers, viz: Sodium, Calcium, Magnesium, Iron, Silicon, Sulphur, Chlorine, Carbon, Hydrogen and Oxygen, which are necessary or advantageous to the growth of vegetation are either so abundant in the soil or may be so cheaply supplied to crops, that they do not considerably affect either the value or cost of high-priced commercial fertilizers.

Nitrogen in fertilizers is, on the whole, the least abundant of their valuable elements and is, therefore, their most costly ingredient.

Free Nitrogen is universally abundant, making up nearly four-fifths of the common air, and appears to be assimilable, with aid of certain bacteria, by leguminous plants (the clovers, alfalfa, peas, beans, lentils, esparsette, lupins, vetches, lathyrus, peanut, yellow locust, honey locust, etc.), and by a few non-leguminous plants, carrying root-nodules, viz: the Oleasters (*Eleagnus*), the Alders (*Alnus*), and a single family of coniferous trees (*Podocarpus*), but not at all, according to present evidence, by the cereals or other field and garden crops.

Organic Nitrogen is the nitrogen of animal and vegetable matters which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly

* Prepared and revised by the Director.

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active as fertilizers; others as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated. Since organic nitrogen may readily take the form of ammonia it has been termed *potential ammonia.*

Ammonia (NH_3) *and nitric acid* (N_2O_5) are results of the decay of *organic nitrogen* in the soil and manure heap, and contain nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda. 17 parts of ammonia or 66 parts of pure sulphate of ammonia contain 14 parts of nitrogen. 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

PHOSPHORUS is, next to nitrogen, the most costly ingredient of fertilizers, in which it exists in the form of phosphates, usually those of calcium, iron and aluminum, or in case of "superphosphates," to some extent in the form of free phosphoric acid.

Water-Soluble Phosphoric acid is phosphoric acid (or a phosphate) that freely dissolves in water. It is the characteristic ingredient of superphosphates, in which it is produced, by acting on "insoluble" or ("citrate soluble") phosphates, with diluted sulphuric acid. Once well incorporated with the soil, it gradually "reverts" and becomes insoluble, or very slightly soluble in water.

Citrate-soluble Phosphoric acid signifies the phosphoric acid (of various phosphates) that is freely taken up by a hot strong solution of neutral ammonium citrate, which solution is therefore used in analysis to determine its quantity. The designation *citrate-soluble* is synonymous with the less explicit terms *reverted, reduced* and *precipitated,* which all imply phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid.

Recent investigation tends to show that water-soluble and citrate-soluble phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the water-soluble gives better results on crops, in others the "reverted" is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric acid implies various phosphates insoluble both in water and in hot solution of neutral ammonium citrate. The phosphoric acid of Canadian "Apatite," of South Carolina and Florida "Rock Phosphate" and of similar dense mineral phosphates, as well as that of "bone-ash" and "bone-black" is mostly insoluble in this sense, and in the majority of cases, gives no visible good results when these substances, in the usual ground state, are applied to crops. They contain however a small proportion of citrate-soluble phosphoric acid and sometimes, when they are reduced to extremely fine dust (floats) or are applied in large quantities, especially on "sour soils" or in conjunction with abundance of decaying vegetable matter (humus), they operate as efficient fertilizers.

Available Phosphoric acid is an expression properly employed in general, to signify phosphoric acid in any form, or phosphates of any kind that serve to nourish vegetation. In the soil phosphoric acid and all phosphates, whatever their solubilities as defined in the foregoing par-

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agraphs, are more or less freely and extensively available to growing plants. Great abundance of "insoluble" phosphoric acid may serve crops equally well with great solubility of a small supply, especially when the soil and the crop carry with them conditions highly favorable to the assimilation of plant food.

In Commercial Fertilizers, "available phosphoric acid" is frequently understood to be the sum total of the "water-soluble" and the "citrate-soluble," with exclusion of the "insoluble."

The "insoluble phosphoric acid" in a commercial fertilizer costing $20 to $50 per ton has very little or no value to the purchaser, because the quantity of it which can commonly go upon an acre of land has no perceptible effect on the crop and because its presence in the fertilizer excludes an equal percentage of more needful and much more valuable ingredients.

In Raw Bone the phosphoric acid (calcium phosphate) is nearly insoluble, because of the animal matter of the bones, which envelops it; but when the animal matter decays in the soil, or when it is disintegrated by boiling or steaming, the phosphate mostly remains in an available form. The phosphoric acid of "Basic-Slag" and of "Grand Cayman's Phosphate" is in some soils as freely taken up by crops as water-soluble phosphoric acid, but in other soils is much less available than the latter.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5) also termed among chemists, phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of Fertilizers, which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride). In unleached wood-ashes it exists mainly as potassium carbonate.

VALUATION OF FERTILIZERS.

The valuation of a fertilizer as practised at this station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemcal composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend, for their trade-value exclusively on the three substances, *nitrogen*, *phosphoric acid* and *potash*, which are comparatively costly and steady in price. The trade-value

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per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above named ingredients*, a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

TRADE-VALUE OF FERTILIZER ELEMENTS, FOR 1894.*

The average Trade-values or retail costs in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash in raw materials and chemicals, as found in New England, New York and New Jersey markets during 1894, were as follows:

	Cts. per lb.
Nitrogen in ammonia salts	19
nitrates	14½
Organic nitrogen in dry and fine ground fish, meat and blood	18½
in cotton seed meal and castor pomace	15
in fine bone and tankage	16½
in fine-medium bone and tankage	15
in medium bone and tankage	12
in coarser bone and tankage	7
in hair, horn shavings and coarse fish scrap	7
Phosphoric acid, water-soluble	6
citrate-soluble†	5½
of dry ground fine fish, bone and tankage	5½
of fine-medium bone and tankage	4½
of medium bone and tankage	3
of coarse bone and tankage	2
of fine ground fish, cotton seed meal, castor pomace and wood ashes	5
of mixed fertilizers insoluble in ammonium citrate	2
Potash as high-grade sulphate and in forms free from muriate (or chlorides)	5½
as muriate	4½

The foregoing are, as nearly as can be estimated, the prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those *raw materials* which are the regular source of supply. They also correspond to the

* Adopted at a conference of representatives of the Connecticut, Massachusetts, New Jersey and Rhode Island Stations held in March, 1894.

† Dissolved from 2 grams of the fertilizer, previously extracted with pure water, by 100 c. c. neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

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average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as :

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried Blood,	Plain Superphosphates,
Azotin,	Dry Ground Fish,
Ammonite,	Bones and Tankage,

Ground South Carolina Rock.

Valuation of Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The Organic Nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality, 18½ cents.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at 4½ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 5½ cents per pound.

In most cases the valuation of the ingredients in superphosphates and specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. The charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts, and finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to 4.50 per ton.

In 1894 the average selling price of Ammoniated Superphosphates and Guanos was $32.93 per ton, the average valuation was $23.30, and the difference $9.63, an advance of 41.3 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of Special manures the average cost was $38.13, the average valuation $28.62 and the difference $9.51 or 33.2 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone*, the sample is sifted into four grades and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton, by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in

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cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

Uses and Limitations of Fertilizer Valuation.

The uses of the "Valuation" are two-fold:

1. To show whether a given lot or brand of fertilizers is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for in some cases analysis cannot discriminate positively between the active and the inert forms of nitrogen, while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second named use of valuation frequent changes of the trade-value are disadvantageous. because two fertilizers cannot be compared as to their relative money-worth, when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of the year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

Agricultural Value of Fertilizers.

The Agricultural Value of a fertilizer is measured by the benefits received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that ground bone superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

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CLASSIFICATION OF FERTILIZERS ANALYZED.

RAW MATERIALS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

Nitrate of Soda	5
Sulphate of Ammonia	2
Dried Blood	1
Ground Horn and Hoof	1
Leather	5
Cotton Seed Meal	16
Castor Pomace	3
Gluten Feed	1

2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*

Dicalcic Phosphate	1
Basic Slag or Odorless Phosphate	1
Concentrated Phosphate	1
Dissolved Bone Black	3
Dissolved Rock Phosphate	1

3. *Containing Potash as the Chief Valuable Ingredient.*

High Grade Sulphate of Potash	3
Double Sulphate of Potash and Magnesia	3
Muriate of Potash	4

4. *Containing Nitrogen and Phosphoric Acid.*

Bone Manures	26
Tankage	17
Dry Ground Fish	9

MIXED FERTILIZERS.

Bone and Potash	11
Nitrogenous Superphosphates and Guanos	76
Special Manures	102
Home Mixtures	7

MISCELLANEOUS.

Cotton Hull Ashes	17
Unleached Wood Ashes	10
Lime Kiln Ashes	1
Saltpeter Waste	2
Sheep Manure	1
Waste from Enameling of Iron	1
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DESCRIPTION AND ANALYSES OF FERTLIZERS.*

I. Raw Materials Chiefly Valuable for Nitrogen.

Nitrate of Soda or Sodium Nitrate.

Nitrate of Soda is mined in Chili and purified there before shipment. It contains about 16 per cent. of nitrogen, equivalent to 97 per cent. of pure sodium nitrate. The usual guarantee is "96 per cent." of sodium nitrate, equivalent to 15.8 per cent. of nitrogen.

4155. Bought by J. Norris Barnes, Yalesville.

4168. From stock of L. Sanderson, New Haven.

4314. From stock of Olds & Whipple.

4380. Sampled from stock of J. C. Lincoln, Berlin, by J. C. Lincoln. Bought of Bowker Fertilizer Co.

4456. Purchased by Station and dried before analysis.

Analyses.

	4155	4168	4314	4380	4456
Moisture	1.79	1.77	1.50	2.80	.42
Insoluble in water	.27	.16	.16	.18	.18
Sodium Chloride (Salt)	.33	.69	.38	.69	.66
Sodium Sulphate	.48	.43	.16	.30	.39
Sodium Nitrate	96.63	96.95	97.80	96.03	98.35
	100.00	100.00	100.00	100.00	100.00
Equivalent Nitrogen	15.94	16.00	16.14	15.84	16.20
Cost per ton	$	50.00	55.00	49.00	....
Nitrogen costs cents per pound		15.6	17.0	15.4	

Sulphate of Ammonia, or Ammonium Sulphate.

This article, now made on a large scale as a by-product of gas-works, usually contains over 20 per cent. of nitrogen, the equivalent of 94–97 per cent. of ammonium sulphate. The rest is chiefly moisture. The usual guarantee is 25 per cent. of ammonia, which is equivalent to 20.6 per cent. of nitrogen, but commercial sulphate of ammonia commonly contains less than that quantity.

* This chapter, pages 19–65, has been prepared for publication by Dr. Jenkins. The analyses of Fertilizers have been made by Messrs. Winton and Ogden with the constant assistance of Mr. Lange.

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4418. Sampled and sent by the Quinnipiac Co., Boston.
4422. Sampled and sent by L. Sanderson, New Haven.

ANALYSES.

	4418	4422
Nitrogen	21.13	20.50
Equivalent Ammonia	25.65	24.88
Retail price per ton	----	$80.00
Nitrogen costs cents per pound	----	19.5

DRIED BLOOD.

This consists of slaughter-house blood which has been dried by superheated steam or hot air. It is a finely pulverized, nearly odorless substance, red or dark red in color, and rich in nitrogen that is quickly available to vegetation.

A single sample, **4457** purchased for vegetation experiments contained 13.20 per cent. of nitrogen.

GROUND HORN AND HOOF.

We are informed that this material is made in Chicago from horns and hoofs that are steamed under high pressure, which makes them brittle, so that they can be ground to a fine powder.

A single sample, **4458** obtained for vegetation experiments contained 15.59 per cent. of nitrogen.

COTTON SEED MEAL.

This material is of two kinds which are known in trade respectively as undecorticated and decorticated. In their manufacture cotton seed is first ginned to remove most of the fiber, then passed through a "linter" to take off the short fiber or lint remaining, then through machines which break and separate the hulls. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer. In case of undecorticated meal the hulls and the ground-press cake are mixed together.

4226. Stock of Smith, Northam & Co., Hartford, sampled and sent by Eugene Brown, Poquonock.

4287. Stock of Smith, Northam & Co., Hartford, sampled and sent by H. H. Austin, Suffield.

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4164. Stock of H. K. Brainard, Thompsonville, sampled and sent by C. D. Woodworth, Thompsonville.

4212. Stock of Olds & Whipple, Hartford, sampled and sent by Eugene Brown, Poquonock.

4143 and **4144.** Samples of two lots of meal made by the Charlotte Oil and Fertilizer Co., Charlotte, N. C., sampled from stock of J. F. Hyde, Hampton, by C. A. Hammond, Elliot.

4321. Stock of L. Sanderson, New Haven, sampled and sent by F. C. Root, Suffield, from a car lot bought by J. H. Van Gelder, Suffield.

4297. Stock of Olds & Whipple, Hartford, sampled and sent by E. J. Wells, E. Windsor Hill.

4289. Stock of R. A. Parker, Warehouse Point, sampled and sent by J. B. Noble, E. Windsor Hill.

4227. Stock of Olds & Whipple, Hartford, sampled by E. J. Wells, E. Windsor Hill.

4288. Stock of W. W. Cooper, Suffield, sampled and sent by H. H. Austin, Suffield.

4199. Stock of Coles & Weeks, Middletown, sampled and sent by J. M. Hubbard, Middletown.

4301. Bought of H. J. Baker & Bro., sampled and sent by E. A. Wildman, New Milford.

This is undecorticated, whence the low content of nitrogen.

4340. Stock of Olds & Whipple, sampled and sent by E. S. Clark, Hartford.

4358. Stock bought of Edward Austin, by H. N. Loomis, Suffield, sampled and sent by F. C. Root.

4359. Stock bought of Edward Austin by H. A. Sheldon, Suffield, sampled and sent by F. C. Root.

The prices quoted in the table represent average *retail* rates. In many cases car lots were bought at from $24.25 to $24.75 per ton at the purchaser's freight station.

The undecorticated **4301,** even at wholesale rates, is not as economical to buy as the hulled meal at retail prices.

Attention is again called to the merits of Cotton Seed Meal as a fertilizer. It is the cheapest supply of available organic nitrogen now in market. Experience demonstrates that it is very prompt to act and quite odorless.

Its use as a fertilizer seems to be mostly confined at present to tobacco, but it is equally valuable for other crops and at present rates, deserves to be used extensively, to replace the higher priced nitrogen of dried blood, tankage and ground bone.

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Analyses of Cotton Seed Meal.

	4226	4287	4164	4212	4143	4144	4321	4297	4289	4227	4288	4199	4201	4340	4358	4359
Nitrogen	7.78	7.62	7.30	7.35	7.27	7.13	7.39	7.39	7.31	7.31	7.27	7.18	4.21	6.98	7.23	7.43
Phosphoric Acid	3.13	2.94	3.13	2.62	2.60	2.87	2.27	2.25	2.26	2.25	2.30	2.48	2.17	....	....	....
Potash	1.84	1.68	1.92	1.94	1.91	1.98	1.70	1.78	1.65	1.69	1.68	1.86	1.62	....	....	....
Cost per ton	$26.50	26.50	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	26.50	27.00	17.50*	....	....	....
Nitrogen costs cents per pound†	**13.8**	**14.3**	**14.3**	**14.5**	**14.6**	**14.7**	**14 9**	**14.9**	**15.1**	**15.1**	**15.4**	**15.7**	**16.2**	....	....	....

* Wholesale, car lots.

† Allowing 5 cents per pound for phosphoric acid and 5¼ cents per pound for potash.

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Castor Pomace.

This is the ground residue of castor beans from which castor oil has been extracted. An excellent fertilizer, but is extremely poisonous to animals which often eat it greedily when the opportunity offers.

4306. Red Seal Castor Pomace, made by the Red Seal Castor Oil Co., St. Louis, Mo., sampled from stock of Olds & Whipple, Hartford.

4204. Collier Castor Pomace, sampled from stock of F. Ellsworth, Hartford.

4213. Baker & Bro's. Castor Pomace, made by H. J. Baker & Bro., N. Y., sampled by W. H. Olcott, So. Manchester, from stock of W. L. Buckland, Burnside.

Analyses.

	4306	4204	4213
Nitrogen	5.59	5.40	5.34
Phosphoric Acid	1.69	1.51	1.39
Potash	1.89	.98	.93
Cost per ton	$24.00	24.00	24.00
Nitrogen costs per pound*	**19.1**	**19.9**	**20.2**

Castor Pomace is regarded by some growers as the very best source of nitrogen for the tobacco crop. They are therefore quite willing to pay a special price for nitrogen in this form. On any other crop there can be no economy in using castor pomace when cotton-seed nitrogen can be bought for four or five cents less per pound.

1570 pounds of cotton seed meal contain as much nitrogen as 2000 pounds of castor pomace and now cost $3.20 less.

In the tests made in 1892 by this Station coöperating with the Conn. Tobacco Experiment Company, wrapper-tobacco grown with aid of castor pomace did not differ either in quality or yield from that manured with cotton seed meal, using equal amounts of nitrogen.

Gluten Feed.

This is a residue from the glucose manufacture much used as feed.

* Allowing 5 cents per pound for phosphoric acid and 5½ cents per pound for potash.

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A sample, **4455,** was sent by H. J. Lathrop of Suffield, with inquiry as to its value as a fertilizer for tobacco.

The sample contained 3.06 per cent. of nitrogen, but no considerable quantities of potash and phosphoric acid.

At the price given, $16 to $17 per ton, the pound of nitrogen costs 26 cents, while in cotton seed meal it costs little more than half as much.

II. Raw Materials of High Grade Containing Phosphoric Acid as the Chief Valuable Ingredient.

Odorless Phosphate.*

4200. Bought of Allison, Stroup & Co., N. Y. city., general agents. Sampled and sent by J. M. Hubbard, Middletown. Cost $19 per ton in car lots.

This material, a by-product of the steel manufacture, contains 21.58 per cent. of phosphoric acid of which 6.42 per cent. is soluble in ammonium citrate.

"Odorless phosphate" contains, besides 20 per cent. or more of phosphoric acid, some 45 to 50 per cent. of lime, 10 of oxide of iron, 5 to 7 of silica and smaller quantities of manganese, alumina and magnesia.

That the phosphoric acid of "odorless phosphate" is so readily available as to make its use profitable under some conditions has been abundantly proved by experience in this country and abroad.

Wagner, from the results of carefully conducted vegetation experiments concluded, that two parts of phosphoric acid in the form of *very finely ground* basic slag have the same crop-producing power *in the first year* as one part of water-soluble phosphoric acid of a superphosphate. When the slag is not extremely fine its fertilizing value is very much less than this.

That is 100 pounds of dissolved bone black and 148 pounds of basic slag, will, on land which is deficient in phosphates, produce about the same crop-increase in the season following the application.

But this statement can only be roughly true in a general sense.

The comparative effect of basic slag and plain superphosphates depends largely on the quality of the soil and the kind of crop.

* Also known as Basic Slag, Thomas Slag or Thomas-Gilchrist Slag.

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In general basic slag will have its best effect on moist soils rich in humus and on crops, like corn, which have a long period of growth. It is recommended for orchards and for grass land before seeding down.

In the reports of this Station for 1887, 1888 and 1889 are recorded the results of field trials with imported basic slag (costing but $12.50 per ton) which illustrate its value as a fertilizer.

At the price now quoted, phosphoric acid in this article costs about 4.4 cents per pound *in car lots.*

This is somewhat more than half the price of water-soluble phosphoric acid in dissolved bone black.

Attention is also called to the analysis given below, No. 4152, of dissolved So. Carolina rock, the price of which was exceptionally low, but whose water-soluble phosphoric acid costs little more than half as much as the phosphoric acid of the basic slag of which two-thirds is insoluble both in water and ammonium citrate.

Dissolved Bone Black and Dissolved Rock Phosphate.

Dissolved Bone Black.

Bone Black, made by subjecting bone to a red heat without access of air, is used in sugar refineries to decolorize sugar solutions. The waste bone black dried, and treated with oil of vitriol makes a "superphosphate" of high grade which does not cake together on standing, but remains as a fine powder suitable for application to the land.

4171. Stock of L. Sanderson, New Haven.

4315. Stock of D. Moriarty, Yalesville, agent of Quinnipiac Co., of Boston.

Dissolved Rock Phosphate or Acid Rock.

4152. This material, made by treating the mineral phosphates mined in So. Carolina and Florida with oil of vitriol, is the most common source of the phosphoric acid of factory-mixed fertilizers.

The per cent. of phosphoric acid in a fertilizer multiplied by 2.18 gives the amount of tricalcium phosphate or so-called "bone phosphate," which figures in commercial transactions and signifies not that the phosphate is in the form of bone, but is reckoned on the same basis in accordance with trade usage.

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4152. Bought in Carteret, N. J., by J. Norris Barnes, Yalesville. The price is exceptionally low even for car lots.

ANALYSES.

	4171	4315	4152
Water-soluble phosphoric acid	17.17	14.51	10.78
Citrate-soluble or reverted phosphoric acid	.23	.37	3.51
Insoluble phosphoric acid	.08	.00	1.42
Total phosphoric acid	17.48	14.88	15.71
Cost per ton	$26.00	24.00	12.00*
Water-soluble phosphoric acid costs cents per pound	7.4	8.2	3.5

This material, which should contain 12–14 per cent. of soluble and reverted phosphoric acid, is apt to cake on keeping, but if mixed promptly with sufficient cotton-seed meal, tankage, or other organic matter, there is no difficulty in handling it.

III. Raw Materials of High Grade containing Potash.

High Grade Sulphate of Potash.

This chemical should contain over 90 per cent. of pure potassium sulphate (sulphate of potash) or about fifty per cent. of potassium oxide the same quantity as is supplied by muriate, and should be nearly free from chlorine.

Two samples, **4337** and **4381,** sent to the Station as "High grade Sulphate of Potash," proved to be cotton hull ashes! The analyses of these goods will be found with the others of cotton hull ashes.

4169. From L. Sanderson, New Haven.

4286. Sampled by H. H. Austin, Suffield, from stock purchased by him.

[For analyses see table on page 27.]

Double Sulphate of Potash and Magnesia.

This material is usually sold as "sulphate of potash" or "manure salt," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27.0 per cent. of potassium oxide. Besides some 46–50 per cent. of potassium sulphate it contains over 30 per cent. of magnesium sulphate, chlorine equivalent to 3 per cent. of common salt, a little sodium and calcium sulphates, with varying quantities of moisture.

* In car lots.

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4170. From L. Sanderson, New Haven.

4295. Sampled and sent by E. J. Wells, East Windsor Hill, from stock of Olds & Whipple, Hartford, agents of Quinnipiac Co., Boston.

4420. Sampled and sent by the Quinnipiac Co., Boston.

[For analyses see the following table.]

Muriate of Potash.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride) 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water.

It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of potassium oxide.

4151. Sampled by J. Norris Barnes, Yalesville, from a supply bought in New York.

4175. Stock of L. Sanderson, New Haven.

4292. Sampled by E. C. Warner, Fair Haven, from goods purchased of L. Sanderson, New Haven.

4419. Sampled and sent by the Quinnipiac Co., Boston.

Analyses.

	4169	4286	4170	4295	4420	4151	4175	4292	4419
Potassium oxide soluble in water	48.96	49.68	26.47	27.34	32.35	56.65	49.07	52.02	44.96
Equivalent sulphate of potash	90.58	91.91	48.96	50.57	59.84	....	....	....	....
Equivalent muriate of potash	....	....	....	....	....	89.50	77.52	82.19	71.03
Cost per ton	$55.00	51.00	30.00	30.00	....	37.80*	42.50	42.50	....
Potassium oxide costs cents per pound	5.6	5.1	5.7	5.5	....		4.3	4.1	....

The average cost of potassium oxide (potash) in the form of high grade sulphate is not far from 5½ cents, its cost in the double sulphate of potash and magnesia is about the same. Potash in the form of muriate is about one and one-quarter cents per pound cheaper.

For all crops except tobacco, sugar beets and possibly potatoes, muriate of potash is altogether the most economical source of supply.

* f. o. b., New York.

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If muriate is applied in moderate quantity in the fall or very early spring to potato land no damage to the quality or productiveness of the crop need be feared.

IV. Raw Materials containing Nitrogen and Phosphoric Acid.

Bone Manures.

The terms "Bone Dust," "Ground Bone," "Bone Meal" and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease and—if taken from garbage or ash heaps—with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam-tanks to recover grease, and are then dried and sometimes sold as "tankage;" or, finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. The nitrogen of all these varieties of bone when they are in the same state of mechanical subdivision has essentially the same fertilizing value.

The method adopted for the valuation of bone manures, which takes account of their mechanical condition as well as chemical composition is fully explained on page 16.

1. *Sampled by Station agents.*

On following pages are tabulated eighteen analyses of this class. The last sample **4184** is a mixture of bone and salts of which the latter were perhaps added to dry and preserve the former.

Excluding 4184 from the calculation, the average cost of the seventeen samples of bone manure was $33.59 and the average valuation $32.01.

The valuation during this year has therefore been rather lower than is justified by the market prices.

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Bone Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.	Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Chemical Analysis. Nitrogen.	Chemical Analysis. Phos. Acid.	Mechanical Analysis. Finer than ¼ inch.	Finer than ½ inch.	Finer than 1 inch.	Coarser than 1 inch.
						Valuation exceeds cost.						
4185	Pure Ground Raw Bone.	H. J. Baker & Bro., 93 William St., N. Y. City.	C. O. Jelliff & Co., Southport.	$30.00	$34.13	12.1	3.54	23.28	65	22	13	--
4271	Bone Meal.	Danbury Fertilizer Co., Danbury.	S. D. Woodruff & Sons, Orange.	29.00	32.96	12.0	3.89	22.94	40	42	18	--
4210	Fine Ground Beef Bone.	Armour Packing Co., Kansas City, Kansas.	F. C. Vibert, Hockanum.	33.00	34.87	5.3	3.66	24.20	59	26	15	--
4207	The Rogers & Hubbard Co's Strictly Pure Fine Bone.	The Rogers & Hubbard Co., Middletown.	Marshall Porter, Hebron.	30.00	31.26	4.0	3.95	22.16	47	24	22	7
4319	Ground Bone Meal.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	J. C. Lincoln, Berlin.	32.00	33.30	3.9	2.47	27.12	55	27	15	3
4173	Ground Bone.	L. Sanderson, New Haven.	Manufacturer.	33.00	34.22	3.5	2.62	27.08	61	23	13	3
4208	Swift Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia, Pa.	F. Ellsworth, Hartford.	40.00	41.28	3.1	6.10	22.06	62	31	7	--
						Cost exceeds Valuation.						
4273	The Rogers & Hubbard Co's Pure Raw Knuckle Bone Meal.	The Rogers & Hubbard Co., Middletown.	Manufacturer. J.P.Barstow & Co., Norwich.	38.00 42.00	37.25	2.0	3.98	25.88	52	35	13	--
4313	The Rogers & Hubbard Co's Pure Raw Knuckle Bone Flour.	The Rogers & Hubbard Co., Middletown.	Manufacturer.	40.00	38.94	2.7	4.07	25.94	56	42	2	--
4211	Fine Ground Bone.	Bradley Fertilizer Co., 92 State St., Boston, Mass.	H. H. Davenport, Pomfret. A. C. Sternberg, Hartford. J. F. Elwood, Greens Farms.	31.00 32.00 29.00	29.94	3.5	3.13	21.03	58	25	17	--
4183	Fine Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	S. W. Bray, Milford.	35.00	33.25	5.2	2.26	26.11	66	24	10	--
4317	Ground Bone.	Downs & Griffin, Birmingham	Manufacturer.	30.00	26.62	12.6	4.43	21.79	26	17	28	29
4312	Pure Bone Meal.	Quinnipiac Co., 92 State St., Boston, Mass.	J. W. Gardner, Cromwell.	34.00	29.25	16.2	3.03	20.76	57	25	18	--
4278	Americus Brand Bone Meal.	Williams & Clark Fertilizer Co., 81 Fulton St., N. Y. City.	D. B. Wilson, Waterbury.	36.00	30.56	17.8	2.82	22.45	60	25	14	1
4318	Pure Ground Bone.	Crocker Fertilizer Co., Buffalo, N. Y.	J. F. Holmes, Ridgefield.	40.00	33.03	21.1	4.18	25.20	36	28	27	9
4267	Pure Ground Bone.	Peck Bros., Northfield.	D. B. Wilson, Waterbury.	30.00	22.82	31.4	4.25	21.52	7	19	38	36
4311	Ground Bone.	Quinnipiac Rendering Co., Meriden.	Manufacturer.	30.00	20.47	46.5	4.21	23 36	9	9	15	67
4184	Celebrated Ground Bone.	Lister's Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	30.00	20.29	47.8	1.57	17.76	47	19	14	20

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2. *Sampled by manufacturers; and* 3. *Sampled by consumers.*

Sample **4228** deposited at the Station by the manufacturer in compliance with the law, was analyzed to meet the requirement of the law which calls for an annual analysis of each brand. The sampling agents of the station did not succeed in finding this brand on sale in the State.

The other samples described below were sent in by private parties and this Station is not responsible for the accuracy of the sampling. The Station holds however in each case a written certificate that the sample was drawn in accordance with its printed instructions.

2. *Sampled by manufacturers.*

4228. Bone Meal made by the L. T. Frisbee Co., Hartford.

3. *Sampled by consumers.*

4153. Bone bought in New York by J. Norris Barnes, Yalesville. Sample drawn by him.

4158. Chittenden's Ground Bone. Sold by National Fertilizer Co. Bridgeport. Sampled and sent by T. J. Stroud, Shaker Station.

4296. Bone bought of Olds & Whipple, Hartford. Sampled and sent by E. J. Wells, E. Windsor Hill.

4448 and **4449.** Bone bought of H. K. Brainard, Thompsonville, said to be from H. J. Baker & Bro. N. Y.

4448. Sampled and sent by T. J. Stroud, Shaker Station.

4449. Sampled and sent by Sumner F. Sikes, Suffield.

MECHANICAL ANALYSES.

	4228	4153	4158	4296	4448	4449
Fine, smaller than $\frac{1}{60}$ inch.....	96	0	67	60	57	57
Fine medium, smaller than $\frac{1}{35}$ inch,	4	37	20	23	42	42
Medium, smaller than $\frac{1}{15}$ inch...	0	60	11	16	1	1
Coarse, larger than $\frac{1}{15}$ inch.	0	3	2	1	0	0
	100	100	100	100	100	100

CHEMICAL ANALYSES.

Nitrogen.....	2.53	4.10	2.78	2.82	3.72	3.80
Phosphoric acid	26.80	24.78	26.00	22.43	21.11	21.30
Cost per ton	$....	22.50*	....	33.00	....	32.00
Valuation per ton.....	$37.59	28.11	34.36	30.36	33.15	33.60

* Car lot.

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Sample No. **4209** was reported by the sampling agent to have been drawn from stock of G. S. Butler, Cromwell, labelled The Rogers & Hubbard Co's. Strictly Pure Fine Bone.

The Rogers & Hubbard Co. object that the analysis does not represent the composition of the brand named, see No. **4207** in the table page 29, and that there is probably some mistake about the sample.

The analysis of Sample No. **4375,** Pure Fine Ground Bone made by the Rogers Manufacturing Co. Rockfall, sent by the manufacturers, is objected to by them because the sample is coarser than the average of their ground bone. For these reasons the two analyses are not included in the foregoing Table.

MECHANICAL ANALYSES.

	4209	4375
Fine, smaller than $\frac{1}{60}$ inch	49	21
Fine medium, smaller than $\frac{1}{30}$ inch	40	30
Medium, smaller than $\frac{1}{15}$ inch	11	40
Coarse, larger than $\frac{1}{15}$ inch	0	9
	100	100

CHEMICAL ANALYSES.

Nitrogen	3.60	4.23
Phosphoric acid	25.80	21.74
Cost per ton	$30.00	----
Valuation per ton	$36.02	$28.20

TANKAGE.

This name is applied to the sediment remaining in tanks where meat scrap and bone are cooked with water to separate the fat. After boiling or steaming, the fat rises to the surface and is removed, the soup is run off, and the settlings at the bottom are dried and sold as tankage.

Sampled by Station Agent.

4123. Made by C. H. Davis & Co. Norwich.

4172. Pulverized Bone and Meat. Stock of L. Sanderson, New Haven.

4174. Blood, Bone and Meat. Stock of L. Sanderson, New Haven.

4252. Bone Fertilizer. Made by Plumb & Winton, Bridgeport.

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4316. Bone Tankage. Made by Geo. F. Taylor & Brush, New York City.

MECHANICAL ANALYSES.

	4123	4172	4174	4252	4316
Fine, smaller than $\frac{1}{50}$ inch	30	71	63	64	53
Fine medium, smaller than $\frac{1}{25}$ inch	32	19	20	22	19
Medium, smaller than $\frac{1}{12}$ inch	20	9	11	13	18
Coarse, larger than $\frac{1}{12}$ inch	18	1	6	1	10
	100	100	100	100	100

CHEMICAL ANALYSES.

Nitrogen	4.92	3.79	5.29	5.40	6.27
Phosphoric acid	15.03	24.03	17.49	18.04	17.47
Valuation per ton	$25.47	36.24	32.88	34.48	33.88
Cost per ton	$20.00	35.00	35.00	30.00	21.90*

Sampled by manufacturer or consumers.

4421. Tankage sold and sampled by the Quinnipiac Co., Boston.

4426. Bone Tankage. Sold and sampled by C. Buckingham, Southport.

4070. Acidified Tankage bought and sampled by Geo. Butler, Cromwell.

4154. Tankage made by the Meriden Provision Co., Meriden. Sampled by J. Norris Barnes, Yalesville.

4298. Bone and Meat. Stock of A. Pouleur, Windsor. Sampled and sent by E. J. Wells, E. Windsor Hill.

MECHANICAL ANALYSES.

	4421	4426	4070	4154	4298
Fine, smaller than $\frac{1}{50}$ inch	69	24	40	58	55
Fine medium, smaller than $\frac{1}{25}$ inch	20	27	32	15	18
Medium, smaller than $\frac{1}{12}$ inch	11	37	20	11	14
Coarse, larger than $\frac{1}{12}$ inch	0	12	8	16	13
	100	100	100	100	100

CHEMICAL ANALYSES AND VALUATIONS.

Nitrogen	5.67	4.57	4.55	5.89	2.88
Phosphoric acid	11.95	16.12	4.39†	13.24	25.10
Valuation per ton	$29.84	24.69	14.45	28.77	30.97

*Car lots.

† Of which 3.98 per cent. is soluble in water.

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Dry Ground Fish.

This material is often sprinkled with diluted oil of vitriol to hinder decay during drying, and the bones of the fish are as a result softened and to some extent dissolved.

4203. Pure Dry Fish Guano. Made by The Miles Fertilizer and Oil Co., Milford. Sampled by Station agent from stock of Olds & Whipple, Hartford.

4379. Dry Ground Fish. Sold by Quinnipiac Co. Boston. Sampled by Station agent from stock of D. C. Wood, Stratford.

4293. Dry Ground Fish. Made by Leander Wilcox, Mystic. Sampled and sent by H. H. Austin, Suffield.

Analyses.

	4203	4379	4293
Nitrogen as ammonia	.35	----	.27
Nitrogen, organic	8.55	7.97	8.96
Total nitrogen	**8.90**	**7.97**	**9.23**
Water-soluble phosphoric acid	.48	.52	.86
Citrate-soluble (reverted) phosphoric acid	5.50	5.08	4.26
Insoluble phosphoric acid	1.34	.90	2.36
Total phosphoric acid	**7.32**	**6.50**	**7.48**
Cost per ton	$38.00	38.00	35.00*
Valuation per ton	$40.14	36.06	40.84

Mixed Fertilizers.

Bone and Potash.

4377. Circle Brand Bone and Potash, made by Bradley Fertilizer Co., Boston, and sample furnished by them.

The samples named below were drawn by an agent of this Station.

4266. A1 Fertilizer, made by C. Buckingham, Southport. Stock of R. C. Wilcox, Guilford.

As the results of this analysis were unsatisfactory, Mr. Buckingham asked that another sample be drawn, which is **4427,** A1 Fertilizer, made by C. Buckingham, and drawn from stock at his warehouse.

4268. Self Recommending Fertilizer, made by F. Nuhn, Waterbury, sampled from stock of manufacturer.

4305. Square Brand Bone and Potash, made by Bowker Fertilizer Co., Boston, Mass., sampled from stock of D. B. Wilson, Waterbury.

*In car lots.

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4428. Ground Bone and Potash, made by The E. F. Coe Co., N. Y. Stock of Wheeler & Howes, Bridgeport.

MECHANICAL ANALYSES.

	4377	4266	4427	4268	4305	4428
Fine, smaller than $\frac{1}{10}$ inch	54	60	52	48	63	57
Fine medium, smaller than $\frac{1}{15}$ inch	33	23	24	22	21	26
Medium, smaller than $\frac{1}{25}$ inch	13	13	18	17	13	15
Coarse, larger than $\frac{1}{25}$ inch	0	4	6	13	3	2
	100	100	100	100	100	100

CHEMICAL ANALYSES.

Nitrogen	2.32	4.45	4.57	3.75	1.76	2.10
Phosphoric acid	19.34	10.45	11.00	19.83	18.68	23.19
Potash	3.61	5.75*	5.94†	4.27	1.91	2.03‡
Cost per ton		$36.00	36.00	35.00	29.00	30.00
Valuation per ton	$28.16	29.50	29.71	31.92	25.27	30.75

4182. Was drawn from stock of Elmer S. Banks, Southport. It purported to be E. F. Coe's Bone and Potash.

It contained 1.35 per cent. of nitrogen, 18.04 per cent. of phosphoric acid and 2.48 per cent. of potash.

The manufacturer objected that this analysis did not at all represent the goods and requested that another sample be drawn and tested. The analysis of the second sample is given in the table above, No. **4428.**

The two following samples are called "bone and potash," but they are not stated to contain any nitrogen.

4382. Diamond Brand Bone and Potash, made by Walton, Whann & Co., Wilmington, Del. Stock of W. S. Hill, Southford.

4383. Bone and Potash, made by Great Eastern Fertilizer Co., Rutland, Vt. Stock of J. U. Sanders, North Stamford.

ANALYSES.

	4382	4383
Water-soluble phosphoric acid	11.42	6.56
Citrate-soluble (reverted) phosphoric acid	2.34	4.42
Insoluble phosphoric acid	.67	.33
Potash, as muriate	2.94	2.21
Valuation per ton	$19.19	14.85
Cost per ton	$25.00	30.00

* 5.03 per cent in form of sulphate.

† 5.01 per cent in form of sulphate.

‡ 1.73 per cent in form of sulphate.

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The two following samples were drawn by C. J. Dewey, Buckland. They are said to represent two different lots of Bradley Fertilizer Co.'s Bone and Potash, Circle Brand, shipped direct to Mr. Dewey by the manufacturer.

MECHANICAL ANALYSES.

	4458	4459
Fine, smaller than $\frac{1}{60}$ inch	45	55
Fine medium, smaller than $\frac{1}{30}$ inch	18	27
Medium, smaller than $\frac{1}{15}$ inch	25	14
Coarse, larger than $\frac{1}{15}$ inch	12	4
	100	100

CHEMICAL ANALYSES.

Nitrogen	2.52	2.12
Phosphoric acid	11.77	12.67
Potash	2.46	2.48
Cost per ton	$33.00	33.00
Valuation per ton	$19.33	20.67

II. NITROGENOUS SUPERPHOSPHATES AND GUANOS.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on.

1. *Samples drawn by Station agents.*

In the tables on pages 38 to 43 are tabulated the analyses of fifty-three brands, made on samples collected by the Station agents.

THE GUARANTEES.

The law of Connecticut requires every package of fertilizer to bear a statement of the actual composition of the goods. This statement expresses the quantities of nitrogen, phosphoric acid and potash within certain limits, for instance "nitrogen 2-4 per cent."

If a fertilizer with such a guarantee actually contains 2 per cent. of nitrogen, it justifies the manufacturer's statement.

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It is the lowest figures of the guarantee therefore that purchasers should regard.

Of the fifty-three brands here reported sixteen are below their minimum guarantee in respect of one ingredient, and two in respect of two ingredients. That is, more than one-fourth of all the nitrogenous superphosphates in our market contain less of one or of two ingredients than they are claimed to contain.

It is urged that an excess of one ingredient over the guarantee should be held to make good the deficiency of another. But with reasonable care and skill in the manufacture and in the sampling and analysis of the goods the actual analysis should not fall below the minimum guaranteed in any respect particularly when wide limits are allowed in the guarantees themselves.

Cost and Valuation.

Cost.

The method used to ascertain the retail cash price of the superphosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis when done is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

From the data thus obtained the average prices are computed.

Valuation.

The valuation has been computed in all cases in the usual manner as explained on page 16.

Percentage Difference given in the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid and potash contained in the fertilizer.

This information enables the purchaser to estimate the relative value of the different brands and the relative economy of buying mixed fertilizers or of procuring and compounding the materials needful for a fertilizer.

Which plan is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

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In case a fertilizer has sold at two or more different prices, the *manufacturer's price*, when known has been used in calculating percentage difference.

Otherwise an *average, or nearly average price* forms the basis of comparison between cost and valuation. The price thus employed is printed in heavy-faced type.

The average cost of the nitrogenous superphosphates is $32.93. The average valuation is $23.30, and the percentage difference 41.3.

Last year the corresponding figures were :

Average cost $32.99, average valuation $23.48, percentage difference 40.5.

These valuations it must be remembered are based on the assumption that the nitrogen, phosphoric acid and potash in each fertilizer are readily available to farm crops. Chemical examination can show pretty conclusively whether this is true in respect of potash. There is less certainty regarding phosphoric acid, while chemical examination, as it is usually made, gives little or no clue as to the availability of the organic nitrogen of mixed goods. This Station has been for some years engaged in a study of methods for determining approximately the relative availability of nitrogen, and on subsequent pages is given a report of the work done during the past year on this point.

While various inferior or agriculturally worthless forms of nitrogen are in the market the main security of purchasers of mixed fertilizers is in dealing with firms which have an established reputation and in avoiding "cheap" goods offered by irresponsible parties.

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Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4464	Pure Fine Bone Dissolved in Sulphuric Acid.	Mapes' Formula & Peruvian Guano Co., N. Y. City.	Mapes' Branch, Hartford.	$32.00*
4309	Flour of Bone Phosphate.	George W. Miller, Middlefield.	Manufacturer.	36.00
4349	Nameless Phosphate.	Danbury Fertilizer Co., Danbury.	L. P. Russell, Orange.	30.00
4251	Ammoniated Bone Phosphate.	Preston Fertilizer Co., Greenpoint, L. I.	S. D. Woodruff & Sons, Orange.	29.00
4254	Bone, Fish and Potash.	E. R. Kelsey, Branford.	Wilson & Burr, Middletown.	28.00
4276	Complete Fertilizer.	Rogers Mfg. Co., Rockfall.	John Lewis. Willimantic.	30.00
			R. H. Tucker, Saybrook.	34.00
				32.00
4178	Formula A.	L. Sanderson, New Haven.	N. E. Smith & Son, Woodmont	----
			C. O. Jelliff & Co., Southport.	36.00
4348	Vegetable Bone Phosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	J. F. Holmes, Ridgefield.	44.00
			G. S. Butler, Cromwell.	42.00
4389	Fish and Potash.	National Fertilizer Co., Bridgeport.	Thomas Kirkham, Newington.	30.00
4232	A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., 93 William St., N. Y. City.	D. N. Benton, Guilford.	34.00
			Saxton & Strong, Bristol.	36.00
				35.00
4430	Swift Sure Superphosphate.	M. L. Shoemaker & Co., Philadelphia, Pa.	F. Ellsworth, Hartford.	38.00
4224	Complete Manure, A Brand.	Mapes' Formula & Peruvian Guano Co., N. Y. City.	Wheeler & Howes, Bridgeport.	35.00
			Will. Foot, Branford.	33.50
			Mapes' Branch, Hartford.	35.00
			Manchester Elevator Co., Manchester.	37.00
			G. K. Nason, Willimantic.	37.00
4188	Complete Manure for General Use.	Mapes' F. & P. G. Co., N. Y. City.	Manchester Elevator Co., Manchester.	40.00
			G. K. Nason, Willimantic.	38.00
4179	Standard Phosphate.	Lister Bros., Newark, N. J.	A. N. Clark, Milford.	32.00
4386	High Grade General Fertilizer.	Soluble Pacific Guano Co., Boston, Mass.	R. H. Tucker, Saybrook	39.00
4364	Fish and Potash.	Leander Wilcox, Mystic.	Manufacturer.	34.00
4367	Olds & Whipple Special Phosphate.	Olds & Whipple, Hartford.	Olds & Whipple, Hartford.	38.00
4353	Success Phosphate.	Lister Bros., Newark, N. J.	W. H. Parmelee, Essex.	28.00
4181	Ammoniated Dissolved Bone.	Lister Bros., Newark, N. J.	A. N. Clark, Milford.	30.00
4390	Ammoniated Bone Phosphate.	National Fertilizer Co., Bridgeport.	T. H. Eldridge, Norwich.	34.00
			G. A. & H. B. Williams, East Hartford.	31.00
			E. B. Clark. Milford.	28.00
			Henry Child. Woodstock.	30.00

* The full-face figure is the one used in calculating the percentage difference.

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ANALYSES.

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
$31.64	1.1	....	....	2.94	2.94	*2.1*	3.47	13.76	3.66	20.89	*12.0*	17.23	....	....	....	....
32.06	12.2	1.18	....	2.07	3.25	*3.0*	8.29	3.10	.66	12.05	*11.0*	11.39	....	8.18	8.18	*7.0*
26.47	13.3	....	....	3.62	3.62	*2.1*	....	7.26	3.38	10.64	*8.0*	7.26	....	4.15	4.15	*2.0*
25.38	14.2	....	.30	2.93	3.23	*2.5*	6.26	3.03	.61	9.90	*9.0*	9.29	....	.81	2.32	*2.0*
24.35	14.9	....	.89	2.63	3.52	*2.5*	3.84	2.49	.13	6.46	*5 0*	6.33	....	.59	3.74	*3.0*
26.95	18.7	.36	....	2.51	2.87	*2.6*	3.04	6.40	.54	9.98	*10.0*	9.44	....	.72	5.54	*5.0*
29.05	20.4	1.07	.16	2.58	3.81	*3.3*	4.74	2.77	1.89	9.40	*10.0*	7.51	*7.0*	1.20	6.16	*6.0*
33.38	25.8	.90	....	4.82	5.72	*5 0*	4.82	1.40	.29	6.51	*7.0*	6.22	*6.0*	6.11	6.11	*6.0*
23.66	26.7	....	....	2.64	2.64	*3.0*	4.86	3.11	1.64	9.61	*6.0*	7.97	....	4.42	4.42	*4.0*
27.55	27.0	.38	1.61	1.30	3.29	*2.5*	5.31	4.68	2.81	12.80	*10.0*	9.99	....	3.20	3.20	*2.0*
29.89	27.1	.84	....	2.04	2.88	*2.5*	7.10	5.53	1.76	14.39	*14.0*	12.63	*9.0*	.59	4.47	*4.0*
27.32	28.1	.74	.39	1.90	3.03	*2 5*	7.18	4.34	1.29	12.81	*12 0*	11.52	*10.0*	3.05	3.05	*2.5*
29.12	30.4	1.24	.51	1.97	3.72	*3.3*	4.66	5.28	1.51	11.45	*10.0*	9.94	*8.0*	4.76	4.76	*4.0*
24.17	32.3	....	.41	2.16	2.57	*2.3*	7.94	2.21	2.57	12.72	....	10.15	*10 0*	1.81	1.81	*1.5*
29.45	32.4	1.55	....	2.13	3.68	*3.3*	4.00	5.15	1.15	10.30	*9.0*	9.15	*8.0*	6.82	6.82	*7.0*
25.57	32.9	....	.27	3.48	3.75	*3.3*	3.49	2.56	.47	6.52	*6.0*	6.05	*5.0*	4.96	4 96	*4.0*
28.30	34.2	1.03	.74	1.59	3.36	*2.7*	5.09	6.67	1.61	13.37	*10.0*	11.76	*8.0*	1.00	2.55	*2.0*
20.32	37.7	....	....	1.49	1.49	*1.2*	8.53	1.80	1.95	12.28	....	10.33	*9.5*	1.32	1.91	*2.0*
21.52	39.4	....	.37	1.72	2.09	*1.8*	7.12	2.44	2.31	11.87	....	9.56	*9.0*	1.79	1.79	*1.5*
22.01	40.8	....	.20	2.11	2.31	*1.6*	2.96	6.85	.77	10.58	*9 0*	9.81	*7.0*	2.27	2.27	*2.0*

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Nitrogenous Superphosphates and Guanos Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4190	High Grade Ammoniated Bone Superphosphate.	The E. Frank Coe Co., 133 Front St., N. Y. City.	E. S. Banks, Southport.	$33.00
			J. O. Fox & Co., Putnam.	32.00
4361	Old Reliable Superphosphate.	L. Sanderson, New Haven.	A. B. Morse, Guilford.	30.00
4369	Ammoniated Dissolved Bone.	Quinnipiac Co., 92 State St., Boston, Mass.	J. F. Silliman, New Canaan.	33.00
4363	Ammoniated Bone Phosphate.	Leander Wilcox, Mystic.	Manufacturer.	34.00
			Browning & Gallup, New London.	34.00
4192	Bradley's Superphosphate.	Bradley Fertilizer Co., Boston, Mass.	J. F. Elwood, Greens Farms.	35.00
			H. H. Davenport, Pomfret.	34.00
			G. W. Carver & Son, Putnam.	34.00
			Quinnebaug Store, Danielsonville.	36.00
			J. A. Lewis, Willimantic.	35.00
			W. B. Martin, Rockville.	35.00
			Thomas Ryan, Thompson.	34.00
4227	Fish, Bone and Potash for General Gardening.	Read Fertilizer Co., Box 3121, N. Y. City.	W. Tillinghast, Plainfield.	30.00
4249	Fish and Potash, Plain Brand.	Quinnipiac Co., Boston, Mass.	J. W. Gardner, Cromwell.	30.00
			S. V. Osborn & Co., Branford.	32.00
				31.00
4217	Hill and Drill Phosphate.	Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	C. H. Bell, Portland.	37.00
			M. A. Covell, North Grosvenordale.	34.00
			F. Hallock & Co., Birmingham.	35.00
4194	Farmers' New Method Fertilizer.	Bradley Fertilizer Co., Boston, Mass.	Quinnebaug Store, Danielsonville.	34.00
			H. H. Davenport, Pomfret.	31.00
			J. A. Lewis, Willimantic.	30.00
			Thomas Ryan, Thompson.	31.00
			G. W. Carver & Son, Putnam.	33.00
				32.00
4368	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co., Boston, Mass.	D. W. Spencer, Centrebrook.	36.00
4253	Russell Coe's Phosphate.	National Fertilizer Co., Bridgeport.	Wilson & Burr, Middletown.	30.00
4233	Ammoniated Dissolved Bone.	Bowker Fertilizer Co., Boston, Mass.	E. B. Clark, Milford.	28.00
			M. A. Covell, North Grosvenordale.	30.00
4220	Alkaline Bone.	The E. Frank Coe Co., N. Y. City.	J. O. Fox & Co., Putnam.	28.00
			C. H. Lounsbury, Seymour.	32.00
				30.00
4396	Fish and Potash.	Williams & Clark Fertilizer Co., N. Y. City.	F. C. Gould, Silver Lane.	31.00
4238	Fish and Potash.	The E. Frank Coe Co., N. Y. City.	W. T. Andrew, Orange.	28.00
			D. N. Clark, Shelton.	35.00
				32.00

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ANALYSES—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$22.72	40.8	....	.48	1.65	2.13	*2.0*	7.87	2.20	1.83	11.90	*9.0*	10.07	*9.0*	.41	2.14	*1 8*
21.17	41.7	....	.31	2.03	2.34	*1.6*	1.20	5.35	4.14	10.69	*10.0*	6.55	*8.0*	.94	3.45	*3.0*
23.13	42.6	....	....	2.03	2.03	*1.6*	4.59	6.35	3.03	13.97	*10.0*	10.94	*9.0*	.59	1.90	*2.0*
23.75	43.1	....	.39	2.54	2.93	*2.5*	3.50	3.04	.96	7.50	*7.0*	6.54	*6.0*	5.50	5.50	*5.0*
24.40	43.4	.51	.06	2.28	2.85	*2.3*	6.91	3.35	1.13	11.39	*11.0*	10.26	*9.0*	2.02	2.02	*1.5*
20.85	43.8	.76	....	2.01	2.77	*2.5*	2.64	2.30	.51	5.45	*5.0*	4.94	*4.0*	5.90	5.90	*4.0*
21.48	44.3	....	.20	2.42	2.62	*2.1*	4.27	2.84	.62	7.73	*6.0*	7.11	*4.0*	3.64	3.64	*4.0*
24.20	44.6	1.55	....	1.30	2.85	*2.5*	5.82	4.59	2.61	13.02	*12.0*	10.41	*9.0*	2.02	2.02	*2.0*
22.05	45.1	.50	....	1.77	2.27	*1.6*	5.97	3.32	1.48	10.77	*10.0*	9.29	*8.0*	2.93	2.93	*3.0*
24.77	45.3	....	.35	3.38	3.73	*3.3*	4.35	2.23	.40	6.98	*5.0*	6.58	*4.0*	3.44	3.44	*3.0*
20.39	47.1	....	....	2.39	2.39	*1.7*	2.16	5.64	2.31	10.11	*8.0*	7.80	*6.0*	2.04	2.04	*1.0*
20.37	47.2	1.13	....	1.22	2.35	*1.5*	3.84	4.26	4.63	12.73	*10.0*	8.10	*8.0*	1.59	1.59	*2.0*
20.15	48.8	....	.12	1.37	1.49	*1.0*	6.94	2.89	2.31	12.14	*11.0*	9.83	*9.0*	.53	2.16	*3.0*
20.82	48.8	....	.22	2.20	2.42	*2.5*	4.94	2.52	.43	7.89	*6.0*	7.46	*4.0*	3.30	3.30	*4.0*
21.46	49.1	....	....	2.64	2.64	*3.0*	2.29	4.26	2.70	9.25	*6.0*	6.55	*4 0*	3.52	3.52	*2.0*

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NITROGENOUS SUPERPHOSPHATES AND GUANOS SAMPLED BY THE STATION—*Con.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4245	Soluble Pacific Guano.	Soluble Pacific Guano Co., Boston, Mass.	R. H. Tucker, Saybrook.	$35.00
			R. F. Woodford, Plainville	35.00
			Saxton & Strong, Bristol.	36.00
4227	Harvest Home Phosphate.	H. J. Baker & Bro., N. Y. City.	S. J. Hall, Meriden.	30.00
4394	Bay State Fertilizer.	Clark's Cove Fertilizer Co., Boston, Mass.	Henry Fields. Newington.	38.00
			John Ballard, Thompson.	35.00
			E. White. Rockville.	38.00
4223	Quinnipiac Phosphate.	Quinnipiac Co., Boston, Mass.	J. W. Gardner, Cromwell.	34.50
			F.S. Bidwell, Windsor Locks.	35.00
			D. C. Wood, Stratford.	35.00
4346	Fish and Potash, Triangle A Brand.	Bradley Fertilizer Co., Boston, Mass.	A. H. Diamond & Son, Bristol.	33.00
4395	Bay State Fertilizer G. G.	Clark's Cove Fertilizer Co., Boston, Mass.	J. M. Burke, South Manchester.	35.00
4225	Americus Brand Ammoniated Bone Superphosphate.	Williams & Clark Fertilizer Co., New York City.	J. Bramfield, Portland.	35.00
			F. C. Gould, Silver Lane.	33.00
			H. K. Brainard, Thompsonville.	35.00
			Hale, Day & Co., South Manchester.	38.00
			W. B Martin, Rockville.	35.00
4307	New England Favorite.	John S. Reese & Co., Baltimore, Md	John Gunn, Groton.	36.00
4240	Royal Bone Phosphate.	Williams & Clark Fertilizer Co., N. Y. City.	F. C. Gould, Silver Lane.	28.50
			Hale, Day & Co., South Manchester.	35.00
4248	Standard Phosphate.	Read Fertilizer Co., N. Y. City.	W. Tillinghast, Plainfield.	30.00
			J. H. Blackman, Stratford.	30.00
4260	Farmers' Reliable Phosphate.	Chicopee Guano Co., N. Y. City.	F. J. Newton, Branford.	30 00
			H. D. Archer, Southport.	36.00
				33.00
4191	New Rival Superphosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	G. F. Kibbie, Tolland.	31.00
			John S. Wells, Hebron.	31.00
4258	Alkaline Guano.	Clark's Cove Fertilizer Co., Boston, Mass.	A. C. Innis, Stratford.	30.00
			J. M. Burke, South Manchester.	30.00
4370	Four Fold Brand.	Walker, Stratman & Co., Pittsburgh, Pa.	W. T. Dudley, Guilford.	30.00
4371	Vegetable, Vine and Fruit Manure.	Read Fertilizer Co., N. Y. City.	H. L. Foot, Brookfield Junction.	38.00
4244	Standard Fertilizer.	Standard Fertilizer Co., Boston, Mass.	Arnold Warner, South Coventry.	36.00
4195	Sure Crop Phosphate.	Bowker Fertilizer Co., Boston. Mass.	W. Tillinghast, Plainfield.	30.00
			John A. Paine, Danielsonville	28.00
4241	Economical Fertilizer.	Wilkinson & Co., 52–54 William St., N. Y. City.	W. W. Peck, Woodbridge.	32.00

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ANALYSES—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
$23.42	49.4	.23	....	2.30	2.53	*2.5*	4.77	5.76	1.33	11.86	*10.5*	10.53	*8.5*	1.83	1.83	*2.0*
20.06	49.5	....	.84	.92	1.76	.9	2.50	6.59	2.76	11.85	*8.0*	9.09	....	2.35	2.35	*2.0*
23.04	51.9	.68	....	2.04	2.72	*2.5*	5.39	4.28	1.15	10.82	*9.5*	9.67	*8.0*	2.09	2.09	*2.0*
22.98	52.3	.71	.08	1.85	2.64	*2.5*	4.90	4.98	1.63	11.51	*10.0*	9.88	*9.0*	1.96	1.96	*2.0*
21.58	52.9	....	.16	2.33	2.49	*2.0*	3.54	3.08	.83	7.45	*6.0*	6.62	*4.0*	4.87	4.87	*4.0*
22.88	52.9	....	.12	2.23	2.35	*1.9*	5.57	4.68	1.08	11.33	*10.0*	10.25	*8.5*	2.12	2.12	*2.0*
22.85	53.2	.74	....	1.92	2.66	*2.5*	5.92	3.51	1.47	10.90	*10.0*	9 43	*9.0*	2.28	2.28	*2.0*
23.40	53.8	....	.20	2.73	2.93	*2.5*	3.97	5.27	.94	10.18	*10.0*	9.24	*9.0*	1.78	1.78	*2.0*
17.76	60 4	....	....	1.33	1.33	*1.0*	5.31	3.71	1.36	10.38	*8.0*	9.02	*7.0*	2.06	2.06	*2.0*
18.43	62.7	....	....	1.14	1.14	*.8*	6.72	1.99	.69	9.40	*10 0*	8.71	*8.0*	4.09	4.09	*4.0*
19.86	66.1	....	....	1.95	1.95	*1.7*	5.82	2.89	1.75	10.46	*10.0*	8.71	*8.0*	1.98	1.98	*2.0*
18.55	67.1	....	....	1.40	1.40	*1.2*	6.05	3.47	1.47	10.99	*11.0*	9.52	*10.0*	1.89	1.89	*1.6*
17.83	68.2	....	....	1.49	1.49	*1.5*	3.49	4.72	1.59	9.80	*7.0*	8.21	*6.0*	2.56	2.56	*2.0*
17.58	70.6	....	....	1.47	1.47	*1.6*	4.66	3.59	3.07	11.32	*10.0*	8.25	*8.0*	1.52	1.52	*2.0*
22.02	72.5	.29	....	1.78	2.07	*1 6*	5.31	1.40	.31	7.02	*7.0*	6.71	*6 0*	7.29	7.29	*8.0*
20.66	74.2	.35	....	1.80	2.15	*2 0*	6.21	3.06	1.09	10.36	*10.0*	9.27	*8.0*	1.91	1.91	*2.0*
15.24	83.7	.69	....	.37	1.06	*.7*	2.18	6.19	3.20	11.57	*10.0*	8.37	*8.0*	1.04	1.25	*1.0*
14.22	125.0	....	....	1.08	1.08	*1.2*	4.80	1.52	.55	6.87	*6.0*	6.32	....	2.86	2.86	*3.0*

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Nitrogenous Superphosphates, Guanos and Fertilizers Sampled and Sent by the Manufacturers.

Station No.	Name or Brand.	Manufacturer.	Sampled by	Manufacturer's Price per Ton.	Valuation per Ton.	Percentage Diff. per Ton.	Nitrogen.					Phosphoric Acid.							Potash.	
							Nitric Nitrogen.	Ammonic Nitrogen.	Organic Nitrogen.	Total.		Water-soluble.	Citrate-soluble (Reverted).	Insoluble.	Total.		Available.		Found.	Guaranteed.
										Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.		
1404	Fish and Potash, Anchor Brand.	Bradley Fertilizer Co.	Manufacturer.	$ ..	$26.57	..	..	..	3.91	3.91	*2.2*	3.39	3.83	.87	8.09	*5.0*	7.22	*5.0*	3.74	*3.0*
1403	B. D. Sea Fowl Guano.	Bradley Fertilizer Co.	"	..	26.19	..	..	..	2.97	2.97	*2.1*	6.16	5.50	1.25	12.91	*10.0*	11.66	*8.0*	1.40	*1.5*
1402	Original Coe's Superphosphate.	Bradley Fertilizer Co.	"	..	23.48	..	.17	..	2.45	2.62	*1.7*	6.24	4.40	1.04	11.68	*12.0*	10.64	*10.0*	1.30	*1.0*
1408	Great Planet A Fertilizer.	Clark's Cove Fertilizer Co.	"	..	31.12	..	1.30	.22	2.18	3.70	*3.3*	4.53	5.07	1.08	10.68	*9.0*	9.60	*8.0*	7.77	*7.0*
1401	Gold Brand Excelsior Guano.	E. F. Coe Co.	"	..	24.72	..	..	.69	1.23	1 92	..	7.50	2.74	1.31	11.55	..	10.24	..	4.87	..
1406	Cumberland Superphosphate.	Cumberland Bone Phosphate Co.	"	..	23.78	..	.61	..	2.11	2.72	*2.06*	5.98	3.32	1.01	10.31	*10.0*	9.30	*8.0*	3.24	*2.0*
414	Extra Bone Phosphate.	L. B. Darling Fertilizer Co.	"	..	24.17	..	.72	..	1.49	2.21	..	6.19	4.12	.62	10.93	..	10.31	..	4.84	..
412	Pine Island Phosphate.	Quinnipiac Co.	"	..	23.53	..	.11	..	2.43	2.54	*2 06*	5.74	5.00	1.13	11.87	*10.0*	10.74	*9.0*	1.53	*1.0*
411	Standard Complete Manure.	Standard Fertilizer Co.	"	..	30.87	..	1.24	.30	2.12	3.66	*3.30*	4.51	4 97	1.01	10.49	..	9.48	*8.0*	7.79	..
399	Banner Fertilizer.	Walker, Stratman & Co.	"	..	21.23	..	..	..	2.69	2.69	*2.0*	5.71	3.16	.85	9.72	*11.0*	8.87	*9.0*	.68	*1.0*
424	Ammoniated Bone Superphosphate.	Crocker Fertilizer Co.	"	..	23.32	..	..	..	2.49	2.49	*2.9*	7.38	3.43	.91	11.72	*11.0*	10.81	*10.0*	1.24	*1.0*
425	Ammoniated Practical Superphosphate.	Crocker Fertilizer Co.	"	..	15.32	..	..	..	..	1.06	*.82*	4.29	4.20	1.34	9.83	*9.0*	8.49	*8.0*	1.21	*1.0*

Nitrogenous Fertilizer Sampled by Consumer.

394	Market Garden Manure.	Quinnipiac Co., Boston, Mass.	Josiah Hawkins, Southport, from stock of C. F. Godfrey.	..	$29.74	..	.86	.55	1.94	3.35	*3.3*	2.59	7.12	1.93	11.64	*9.0*	9.71	*8.0*	6.97	*7.0*

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2. Sampled by the Manufacturers.

In the preceding table, page 44, are twelve analyses made on samples deposited with the Director of the Station by manufacturers in compliance with the requirements of the Fertilizer Law. The brands named were not found in the Connecticut market by our sampling agents.

3. Sampled by the consumer.

A single analysis of a sample of this kind is given in the preceding table, page 44.

Protest was made by the manufacturers of the two brands named below because the analyses (first made and here given) did not represent the general quality of the goods. In case of Swift Sure Superphosphate it was possible to draw and analyze a second sample, with the results given in the table on page 39 No. **4430,** which are copied below for comparison.

4242. Complete Bone Phosphate, made by L. Wilcox, Mystic, sampled from stock of Browning & Gallup, New London.

4256. Swift Sure Superphosphate, made by L. Shoemaker & Co., Phila., sampled from stock of J. P. Barstow & Co., Norwich.

ANALYSES.

	4242	4256	4430
Nitrogen as nitrate	....	.70	.84
Nitrogen, organic	1.96	1.80	2.04
Total nitrogen	1.96	2.50	2.88
Water-soluble phosphoric acid	7.23	5.39	7.10
Citrate-soluble (reverted) phosphoric acid	2.90	4.96	5.53
Insoluble phosphoric acid	.68	4.39	1.76
Total phosphoric acid	10.81	14.74	14.39
Potash, as muriate	2.49	4.47	4.47
Valuation per ton	$21.63	26.40	29.89

III. SPECIAL MANURES.

1. Sampled by Station Agent.

For Analyses and Valuations see pages 46 to 53.

Here are included such Nitrogenous Superphosphates as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

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Special Manures Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' Cash Price per Ton.
4385	The Rogers & Hubbard Co.'s Soluble Tobacco Manure.	Rogers & Hubbard Co, Middletown.	T. S. Loomis, Windsor. G. S. Butler, Cromwell.	***42.00** 42.00
4355	Seeding Down Manure.	Mapes' Formula & Peruvian Guano Co., New York.	Mapes' Branch, Hartford.	**37.50**
4235	Special Fertilizer for Fruit, Vegetables and Tobacco.	Armour Packing Co., Kansas City, Kansas.	F. C. Vibert, Hockanum.	**35.00**
4272	Potato Manure.	Danbury Fertilizer Co., Danbury.	S. D. Woodruff & Sons, Orange. L. P. Russell, Orange.	**35.00** 35.00
4177	Fairchild's Formula for Corn and General Crops.	Rogers & Hubbard Co., Middletown.	F. T. Bradley, Saybrook.	**46.00**
4176	The Rogers & Hubbard Co.'s Soluble Potato Manure.	Rogers & Hubbard Co., Middletown.	F. T. Bradley, Saybrook.	**38.00**
4373	The Rogers & Hubbard Co.'s Fertilizer for Oats and Top Dressing.	Rogers & Hubbard Co., Middletown.	G. S. Butler, Cromwell.	**50.00**
4374	The Rogers & Hubbard Co.'s Grass and Grain Fertilizer.	Rogers & Hubbard Co., Middletown.	G. S. Butler, Cromwell.	**37.50**
4372	High Grade Corn Fertilizer.	The Rogers Mfg. Co., Rockfall.	W. H. Warner, Wethersfield.	**48.00**
4231	Onion Manure.	H. J. Baker & Bro., New York.	C. O. Jelliff & Co., Southport.	**39.00**
4250	Quinnipiac Havana Tobacco Fertilizer.	Quinnipiac Co., Boston, Mass.	J. W. Gardner, Cromwell.	**48.00**
4265	Soluble Potato and General Crop Manure.	The Rogers Mfg. Co., Rockfall.	R. H. Tucker, Saybrook. W. H. Warner, Wethersfield. F. Hallock, Birmingham.	39.00 **38.00** 38.00
4392	Wrapper Brand Tobacco Manure.	Mapes' F. & P. G. Co., New York.	Mapes' Branch, Hartford.	**48.00**
4350	Tobacco Grower.	L. B. Darling Fertilizer Co., Pawtucket, R I.	F. S. Bidwell, Windsor Locks.	**40.00**
4234	Potato Manure.	H. J. Baker & Bro., New York.	D. N. Benton, Guilford. C. O. Jelliff & Co., Southport. Saxton & Strong, Bristol.	**40.00** 38.00 41.00
4354	Tobacco Starter.	Mapes' F. & P. G. Co., New York.	Mapes' Branch, Hartford.	**35.00**
4325	Complete Manure for Corn and Grain.	Bradley Fertilizer Co., 92 State St., Boston, Mass.	M. Beach & Son, New Milford. Lewis & Judson, Stratford. Strong & Tanner, Winsted.	40.00 38.00 **38.00**
4216	Complete Manure for Light or Sandy Soils.	Mapes' F. & P. G. Co, New York City.	C. O. Jelliff & Co., Southport. Mapes' Branch, Hartford. G. K. Nason, Willimantic.	40.00 **42.00** 44.00
4236	Stockbridge Tobacco Manure.	Bowker Fertilizer Co., Boston, Mass.	H. K. Brainard, Thompsonville.	**50.00**

* Where several quotations are made the full-face figure indicates the one used in calculating the percentage difference.

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Analyses.

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.						Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$42.91	*2.1	1.15	.20	4 52	5.87	*5.0*	2.05	5.80	.25	8.10	*10.0*	7.85	....	.28	10.40	*10.0*
36.83	1.8	.99	.16	1.16	2.31	*2.5*	....	....	....	18.01	*18.0*	....	....	11.73	11.73	*10.0*
32.73	6.9	....	....	....	6.94	*7.4*	.. .	....	....	11.17	*9.16*	....	....	....	....	....
31.68	10.4	....	....	4.03	4.03	*2.9*	....	7.75	3.03	10.78	*8.0*	7.75	....	7.81	7.81	*7.0*
41.33	11.2	4.21	....	1.70	5.91	*5.5*	....	...	....	13.01	*12.0*	....	....	12.16	12.16	*12.5*
34.05	11.6	1.25	....	4.22	5.47	*5.0*	1.74	6.29	.85	8.88	*10.0*	8.03	....	.77	5.54	*5.0*
43.70	14.4	7.62	....	1.58	9.20	*8.8*	..	....	....	8.88	*7.9*	....	....	8.75	8.75	*8.4*
32.55	15.2	....	....	....	3.32	*2.5*	....	....	....	17.24	*16.0*	....	....	11.44	11.44	*12.5*
41.66	15.2	4.14	....	2.02	6.16	*5.5*	....	....	....	12.35	*13.0*	....	....	13.01	13.01	*14.0*
33.46	16.5	.. .	4.21	.51	4.72	*4.9*	4.05	1.00	.54	5.59	....	5.05	*4.5*	9.49	10.30	*9.0*
41.17	16.5	....	3.09	3.21	6.30	*5.8*	.42	3.66	1.10	5.18	*6.0*	4.08	*5.0*	.85	11.25	*10.0*
32.47	17.0	.69	....	3.06	3.75	*3.1*	2.40	6.26	.78	9.44	*10.0*	8.66	....	.77	8.75	*9.0*
40.99	17.1	1.50	2.96	1.85	6.31	*6.2*	.35	5.43	.19	5.97	*4.5*	5.78	....	1.28	11.68	*10.5*
34.09	17.3	....	.69	2.67	3.36	*4.9*	5.01	4.41	1.20	10.62	*10.0*	9.42	....	2.00	10.05	....
33.66	18.8	.46	2.15	1.57	4.18	*3.3*	3.44	2.52	2.18	8.14	....	5.96	*5.0*	4.61	10.73	*10.0*
29.26	19.6	.82	.43	1.90	3.15	*2.5*	6.85	5.41	.98	13.24	*12.0*	12.26	*8.0*	....	3.48	*2.5*
31.52	20.5	1.54	....	2.00	3.54	*3.3*	4.27	10.38	2.72	17.37	*13.0*	14.65	*12.0*	2.24	2.24	*3.0*
34.02	23.4	1.59	1.33	2.42	5.34	*4.9*	3.39	4.30	1.21	8.90	*8.0*	7.69	*6.0*	6.80	6.80	*6.0*
40.49	23.4	3.11	....	2.86	5.97	*5.8*	.58	5.90	4.75	11.23	*4.0*	6.48	....	.52	11.31	*10.0*

* Valuation exceeds cost.

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Special Manures, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' Cash Price per Ton.
4226	Tobacco Manure.	H. J. Baker & Bro., New York.	E. F. Hawley, Newtown.	$42.50
4222	Corn Manure.	Mapes' F. & P. G. Co., New York.	G. K. Nason, Willimantic.	41.00
			Mapes' Branch, Hartford.	39.00
			Will. Foot, Branford.	38.50
4391	Grass and Grain Spring Top Dressing.	Mapes' F. & P. G. Co., New York.	J. P. Barstow & Co., Norwich.	40.00
			Birdsey & Foster, Meriden.	40.00
			Southington Lumber & Feed Co.	40.00
			Mapes' Branch, Hartford.	39.00
			G. K. Nason, Willimantic.	40.00
4197	Stockbridge Top Dressing.	Bowker Fertilizer Co., Boston, Mass	John A. Paine, Danielsonville.	40.00
			John Lewis, Willimantic.	40.00
4243	Potato, Onion and Tobacco Manure.	Leander Wilcox, Mystic.	Browning & Gallup, New London.	36.00
4219	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston, Mass.	J. F. Elwood, Greens Farms.	38.00
			Buckley & Hanmer, Wethersfield.	38.00
			Lewis F. Judson, Stratford.	38.00
			J. C. Lincoln, Berlin.	38.00
4210	Peerless Potato Manure.	Walton & Whann Co., Wilmington, Del.	W. S. Hill, Southford.	38.00
4221	Potato Manure.	Mapes' F. & P. G. Co., New York.	Wilson & Burr, Middletown.	42.00
			G. K. Nason, Willimantic.	43.00
			Manchester Elevator Co., Manchester.	43.00
			Mapes' Branch, Hartford.	41.00
			Wheeler & Howes, Bridgeport.	45.00
4384	High Grade Special for Potatoes, Tobacco, Onions and Cabbage.	Williams & Clark, 81 Fulton St., N. Y. City.	J. Bransfield, Portland.	40.00
			F. C. Gould, Silver Lane.	39.00
			Hale, Day & Co., South Manchester.	42.00
			S. D. Woodruff & Sons, Orange.	37.00
4180	Potato Manure.	Lister's Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	38.00

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ANALYSES.

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.						Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
$34.28	23.9	--	2.50	1.88	4.38	*4.5*	4.59	.83	.40	5.82	----	5.42	*5.5*	.49	10.78	*10.0*
31.39	24.2	1.44	.60	1.92	3.96	*3.7*	5.95	3.93	1.40	11.28	*10.0*	9.88	*8.0*	6.46	6.46	*6.0*
30.74	26.8	2.01	.88	1.90	4.79	*4.1*	3.71	4.09	.55	8.35	*7.0*	7.80	*5.0*	5.97	5.97	*5.0*
31.47	27.1	3.11	----	2.02	5.13	*5.0*	2.90	3.71	3.07	9.68	*6.0*	6.61	*4.0*	6.88	6.88	*6.0*
28.07	28.2	.76	.30	2.46	3.52	*3.3*	4.22	3.31	1.25	8.78	*8.0*	7.53	*7.0*	1.54	6.34	*6.0*
29.30	29.6	1.50	.05	2.18	3.73	*3.7*	4.61	4.37	1.63	10.61	*9.0*	8.98	*8.0*	6.33	6.33	*6.0*
29.28	29.7	1.60	.06	1.62	3.28	*3.3*	6.24	1.07	.39	7.61	*7.0*	7.31	----	10.70	10.70	*9.0*
31.27	31.1	2.16	.46	1.31	3.93	*3.7*	4.50	3.83	1.00	9.33	*8.0*	8.33	*8.0*	.89	8.12	*6.0*
29.38	32.7	1.32	----	2.20	3.52	*3.7*	3.68	5.70	1.14	10.52	*8.0*	9.38	*7.0*	6.95	6.95	*7.0*
28.54	33.1	1.57	.29	1.83	3.69	*3.7*	6.30	1.86	.76	8.92	----	8.16	*7.5*	6.89	6.89	*7.0*

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Special Manures, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4270	Corn Fertilizer.	M. E. Wheeler & Co, Rutland, Vermont.	P. Rourke, Orange.	------
			S. J. Peck, Woodbridge.	$32.00
4257	Special Phosphate for Potatoes.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	G. S. Butler, Cromwell.	40.00
			Will. Foot, Branford.	40.00
4351	Wheat and Corn Phosphate.	Darling Fertilizer Co., Pawtucket, R. I	Treat & Clark, Orange.	32.00
4196	Stockbridge Potato Manure.	Bowker Fertilizer Co., Boston, Mass.	A. M. Williams, Manchester.	40.00
			J. A. Lewis, Willimantic.	40.00
			M. A. Covell, No. Grosvenor Dale.	38.00
				39.00
4255	Vegetable, Vine and Tobacco Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vermont.	C. Grant, Buckland.	33.00
			G. L. Beach, Branford.	33.00
			S. C. Lewis, Stratford.	33.00
4187	Potato, Hop and Tobacco Phosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	G. F. Kibbie, Tolland.	35.00
			John S. Wells, Hebron.	34.00
4275	Potato and Root Crop Manure.	Darling Fertilizer Co., Pawtucket, R. I.	F. S. Bidwell, Windsor Locks.	38.00
			Treat & Clark, Orange.	37.00
			S. W. Bray, Milford.	40.00
4218	Stockbridge Corn Manure.	Bowker Fertilizer Co., Boston, Mass.	J. F. Hutchinson, Windsor.	41.00
			John A. Paine, Danielsonville.	40.00
			J. A. Lewis, Willimantic.	40.00
4269	High Grade Potato Manure.	M. E. Wheeler & Co., Rutland, Vermont.	S. J. Peck, Woodbridge.	34.00
4262	Tobacco Fertilizer.	Bradley Fertilizer Co., Boston, Mass.	M. Beach & Son, Milford.	40.00
			A. C. Sternberg, Hartford.	40.00
4247	Special Potato Manure.	J. S. Reese & Co., Baltimore, Md.	Donald Gunn, Groton.	38.00
4264	General Fertilizer for Grass and Grain.	Great Eastern Fertilizer Co., Rutland, Vt.	S. C. Lewis, Stratford.	33.00
			F. Morton, Rocky Hill.	34.00
			C. Grant, Buckland.	33.00
4261	Potato Manure.	Chicopee Guano Co., 140 Maiden Lane, N. Y. City.	H. D. Archer, Southport	38.00
			F. J. Newton, Branford.	35.00
				36.50
4193	High Grade Potato Fertilizer.	E. Frank Coe Co., 133 Front St., N. Y. City.	E. S. Banks, Southport.	36.00
			J. O. Fox, Putnam.	
4429	High Grade Potato Fertilizer.	E. Frank Coe Co, 133 Front St., N. Y. City.	I. W. Dennison & Co., Mystic.	35.00
4189	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	G. F. Kibbie, Tolland.	33.00
			John S. Wells, Hebron.	32.00
4366	Americus Potato and Tobacco Manure.	Williams & Clark Fertilizer Co., N. Y.	F. C. Gould, Silver Lane.	33.00

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ANALYSES.

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
23.87	34.0	.80	---	2.52	3.32	*1.7*	6.56	1.80	.85	9.21	*9.0*	8.36	*8.0*	2.27	2.27	*2.0*
29.58	35.2	....	....	3.88	3.88	*3.7*	7.06	1.29	.30	8.65	*9.0*	8.35	*8.0*	5.79	5.79	*5.4*
23.44	36.5	....	....	2.15	2.15	*2.1*	5.76	4.91	2.25	12.92	*9.0*	10.67	....	2.52	2.52	*2.0*
28.49	36.8	2.04	....	1.52	3.56	*3.3*	6.19	2.50	1.86	10.55	*8.0*	8.69	*6.0*	6.70	6.70	*7.0*
23.59	39.8	.52	....	1.67	2.19	*2.1*	6.16	2.30	1.35	9.81	*9.0*	8.46	*8.0*	6.05	6.05	*6.0*
24.14	40.8	....	....	2.30	2.30	*2.0*	7.31	2.73	1.22	11.26	*11.0*	10.04	*10.0*	3.74	3.74	*3.3*
26.88	41.3	.37	.11	2.34	2.82	*2.9*	3.38	4.51	1.70	9.59	*10.0*	7.89	*6.0*	3.18	7.15	*7.0*
28.13	42.1	1.81	....	1.70	3.51	*3.3*	5.41	5.11	2.07	12.59	*10.0*	10.52	*8.0*	4.05	4.05	*4.0*
23.90	42.2	.25	....	1.94	2.19	*2.1*	5.52	2.99	1.89	10.40	*9.0*	8.51	*8.0*	5.91	5.91	*3.8*
27.76	44.0	1.29	....	2.25	3.54	*3.3*	4.48	4.53	1.68	10.68	*10.0*	9.0	*8.0*	5.19	5.19	*7.4*
26.33	44.3	....	.16	2.81	2.97	*3.0*	2.90	4.82	.97	8.69	*7.0*	7.72	*7.0*	6.83	6.83	*7.5*
22.86	44.3	.75	....	2.28	3.03	*2.9*	6.54	1.85	.86	9.25	*9.0*	8.39	*8.0*	2.23	2.23	*2.0*
25.01	45.9	.60	.16	2.20	2.96	*2.9*	5.68	2.17	1.45	9.30	*9.0*	7.85	*7.0*	5.25	5.25	*5.0*
24.29	48.2	....	.27	1.90	2.17	*2.0*	6.74	2 02	1.50	10.26	*10.0*	8.76	*8.0*	.65	5.15	*6.0*
....	....	....	....	....	....	....	....	....	....	....	....	....	....	.60	4.88	....
22.07	49.5	....	....	2.24	2.24	*2.0*	7.28	2.54	1.18	11.00	*11.0*	9.82	*10.0*	1.97	1.97	*1.6*
22.06	49.5	.35	....	1.89	2.24	*2.5*	7.17	2.12	.55	9.84	*9.0*	9.29	*8.0*	1.61	2.99	*3.0*

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SPECIAL MANURES, SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealers' Cash Price per Ton.
4324	Complete Manure for Top Dressing Grass and Grain	Bradley Fertilizer Co., Boston, Mass.	F. S. Bidwell, Windsor Locks.	39.00
			J. F. Elwood, Greens Farms.	38.00
4393	Tobacco Grower.	Bowker Fertilizer Co., Boston, Mass.	M. McNamara, New Milford.	39.00
4246	Special Potato Manure.	Soluble Pacific Guano Co., Boston, Mass.	J. Bramfield, Portland.	35.00
			R. F. Woodford, Plainville.	35.00
4365	Americus Corn Phosphate.	Williams & Clark Fertilizer Co., N. Y. City.	W. B. Martin, Rockville.	35.00
4388	Potato Manure.	Quinnipiac Co., Boston, Mass.	S. V. Osborn & Co., Branford.	38.00
			J. W. Gardner, Cromwell.	35.00
			D. C. Wood, Stratford.	36.00
4239	Potato Phosphate.	Williams & Clark Fertilizer Co., N. Y. City.	Hale, Day & Co., So. Manchester.	38.00
			W. B. Martin, Rockville.	35.00
			F. C. Gould, Silver Lane.	33.00
			J. Bramfield, Portland.	35.00
			D. N. Benton, Guilford.	33.00
			H. K. Brainard, Thompsonville.	38.00
4387	Potato Manure.	Preston Fertilizer Co., Greenpoint, L. I.	W. J. Anderson, Danbury.	38.00
4259	Potato and Tobacco Fertilizer.	Clark's Cove Fertilizer Co., Boston, Mass.	J. M. Burke, So. Manchester	37.00
4198	Potato Manure.	Bradley Fertilizer Co., Boston, Mass.	J. F. Elwood, Greens Farms.	36.00
			Quinebaug Store, Danielsonville.	38.00
			H. H. Davenport, Pomfret.	35.00
			G. W. Carver & Son, Putnam.	36.00
			J. A. Lewis, Willimantic.	38.00
			Thomas Ryan, Thompson.	34.00
4347	Bay State Potato Manure.	Clark's Cove Fertilizer Co., Boston, Mass.	E. White, Rockville.	38.00
			John Ballard, Thompson.	35.00
4362	Potato and Tobacco Fertilizer.	Standard Fertilizer Co., Boston, Mass.	Arnold Warner, So. Coventry.	38.00
4230	Potato Manure.	Bowker Fertilizer Co., Boston, Mass.	W. Tillinghast, Plainfield.	34.00
4352	Oats, Buckwheat, and Seeding Down Manure.	Great Eastern Fertilizer Co., Rutland, Vt.	P. Campbell, Sandy Hook.	35.00
			F. W. Button, Thompsonville.	----
4308	Potato Special.	Walker, Stratman & Co., Pittsburgh, Pa.	W. T. Dudley, Guilford.	40.00
4397	Grass and Oats Fertilizer.	M. E. Wheeler & Co., Rutland, Vt.	S. J. Peck, Woodbridge.	28.00

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ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff. between cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
25.30	50.1	5.20	....	....	5.20	*5.0*	2.35	3.97	1.01	7.33	*6.0*	6.32	*5.0*	.60	2.59	*2.5*
25.75	51.4	1.08	....	1.66	2.74	*2.5*	6.42	4.27	1.05	11.74	*9 0*	10.69	*7.0*	.44	3.54	*4.2*
22.44	55.9	.65	.13	1.83	2.61	*2.5*	2.72	4.24	2.03	8.99	*7.0*	6.96	*5.0*	5.07	5.07	*5.0*
22.66	57.2	.48	....	1.71	2.19	*2.1*	6.08	4.53	1.22	11.83	*10.5*	10.61	*9.0*	1.97	1.97	*1.5*
22.83	57.6	.81	.11	1.74	2.66	*2.5*	2.74	4.82	1.37	8.93	*7.0*	7.56	*6.0*	4.98	4.98	*5.0*
22.11	58.3	.83	....	1.75	2.58	*2.5*	3.81	3.12	1.50	8.43	*7.0*	6.93	*6.0*	5.13	5.13	*5.0*
23.53	61.4	....	.31	1.01	1.32	*3.3*	5.72	4.29	1.03	11.04	*8.0*	10.01	....	3.79	6.85	*7.0*
22.80	62.2	....	....	2.35	2.35	*2.1*	5.52	4.68	2.00	12.20	*9.0*	10.20	*8.0*	1.70	1.70	*3.0*
21.93	64.1	.99	....	1.63	2.62	*2.5*	4.64	2.47	1.03	8.14	*8.0*	7.11	*6.0*	4.81	4.81	*5.0*
21.26	64.6	1.17	....	1.45	2.62	*2.5*	3.60	2.86	.97	7.43	*7.0*	6.22	*6.0*	5.15	5.15	*5.0*
21.37	77.7	.71	....	1.44	2.15	*2 1*	5.49	3.94	1.60	11.03	*9.0*	9.43	*8.0*	2.69	2.69	*3.0*
18.90	79.8	.81	....	.99	1.80	*1.5*	3.54	5.24	2.80	11.58	....	8.78	*11.0*	1.96	1.96	*2.0*
18.10	93.3	....	....	1.12	1.12	*.8*	7.01	1.61	.58	9 20	*9.0*	8.62	*8.0*	3.94	3.94	*4.0*
19.88	101.2	....	.12	1.35	1.47	*2.4*	5.78	1.65	2.80	10.23	*12.0*	7.43	*10.0*	5.05	5.05	*5.4*
13.80	102.8	....	....	....	....	....	6.96	3.13	.50	10.59	*12.0*	10.09	*10.0*	2.01	2.01	*2.0*

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Guarantees.

Of the sixty brands of Special Manures analyzed, twenty-six are quite below the manufacturer's minimum guarantee in respect of one ingredient, four are below in respect of two ingredients and one in respect of all three ingredients. Fully one half therefore are below the manufacturer's guarantee.

Cost, Valuation, and Percentage Difference.

The average cost per ton of the Special Manures has been $38.13. The average valuation, $28.62, and the percentage difference 33.2 per cent. Last year the corresponding figures were, average cost, $37.76, average valuation, $29.35, percentage difference, 28.6 per cent.

Analyses requiring Special Notice.

In the table, page 51 is an analysis of The E. Frank Coe Co's. High Grade Potato Manure, No. **4193.** The sample was drawn from Stock of E. S. Banks, Southport and J. O. Fox & Co., Putnam. Six per cent. of potash is guaranteed by the manufacturer. Protest was made that the sample analyzed, which contained only 5.15 per cent. of potash, did not represent the general quality of the goods. Potash was accordingly determined in another sample of the same brand, **4429,** drawn from Stock of I. W. Dennison & Co., Mystic.

The latter contained 4.88 per cent. of potash of which .60 was in form of muriate. This result confirms the previously made analysis and shows that the goods sold in Southport, Putnam and Mystic were below guarantee in respect to potash.

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The "Chemical Compound Fertilizer" for Tobacco and for Corn.

Samples of fertilizers bearing the names given above have been sent to the Station by John Mason of Warehouse Point and A. D. Nooney of Suffield.

Mr. Mason states that orders for these fertilizers were solicited by a traveling agent and we are otherwise informed that the goods were shipped to the purchasers direct from Providence.

They were offered at the modest price of $50.00 per ton, the purchaser to delay payment till the crop was harvested and proved satisfactory.

It was represented that half a ton was enough to raise a crop of tobacco.

4300 and **4417** are samples of the Chemical Compound for tobacco, sampled from stock at the warehouse of F. S. Bidwell by John Mason, Warehouse Point and A. D. Nooney, Suffield.

4299 is a sample of the Chemical Compound for Corn, sampled by John Mason, Warehouse Point.

The statement of composition given on the tags which were attached to the packages were as follows:

	For Tobacco.	*For Corn.*
Nitrogen	4.21	1.46
Phosphoric acid soluble in the soil	15.75	16.36
Alkali	21.37	24.54

The tags are also marked from Mason, Chapin & Co. Importers of and Dealers in Dyestuffs, Chemicals, Paints, Oils, etc., Providence, R. I.

Following are the results of analyses of the samples:

	4300	**4417**	**4299**
Nitrogen in nitrates	4.03	3.56	1.47
Phosphoric acid soluble in water	.11	.22	.29
" " "reverted"	2.20	2.38	2.08
" " insoluble	11.51	10.08	13.70
" " total	13.82	12.68	16.07
Potash	none.	none.	none.
Valuation per ton	$18.84	17.23	12.38
Cost per ton	$50.00	50.00	50.00

Further knowledge of the composition of these fertilizers is given by the following complete analyses.

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	Chemical Compound Fertilizer for Tobacco.	Chemical Compound Fertilizer for Corn.
	4300	4299
Sand and Silica	11.78	12.66
Oxide of Iron and Alumina	6.92	7.96
Lime	13.80	15.50
Magnesia	.16	.10
Potash	.00	.00
Soda	20.75	21.83
Carbonic Acid	10.22	14.13
Sulphuric Acid	.36	.29
Phosphoric Acid	13.82	16.07
Nitric Acid	15.52	5.62
Chlorine	.45	.25
Water by difference	6.22	5.59
	100.00	100.00

The Fertilizer for Tobacco consists of about 24 to 25 per cent. of nitrate of soda, and 20 per cent. of carbonate of soda mixed with some quite insoluble ground phosphate of iron and lime.

The Fertilizer for Corn consists of about 9 to 10 per cent. of nitrate of soda with correspondingly more carbonate of soda and ground phosphate.

The Tobacco Fertilizer is below the guarantee in respect to both nitrogen and phosphoric acid, the Corn Fertilizer in respect to phosphoric acid alone.

A mixture of 500 pounds of nitrate of soda, costing $12.50, 1200 pounds of basic slag costing $11.40 and 300 pounds of dry carbonate of soda, costing $6.00, total cost $29.90, would contain approximately the same quantities of nitrogen, phosphoric acid and soda and would have at least as great a crop-producing power as these fertilizers costing $50.00 per ton.

The only valuable fertilizing ingredients contained in these fertilizers viz: phosphoric acid and nitrogen could however be bought for not far from $20.00, so that the plant food in these goods costs more than twice as much as the farmer needs to pay for it.

It is claimed that the soda existing in these fertilizers as carbonate and nitrate is an efficient substitute for potash in the plant and in the soil. So far as the plant is concerned a large amount of the most refined investigation would appear to demonstrate conclusively that soda cannot in any sense or to any extent take the place of potash in plant-nutrition. Plants growing in presence of abundance of potash usually take up and contain more potash than they really need. This accidental or unnecessary

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potash may indeed be replaced by soda but both may be withheld without detriment to the plant. Even the salt-worts and sea-weeds which usually grow in soils or water containing much sodium compounds, flourish equally well in absence of soda, but cannot exist in default of potash.

On the other hand soda may sometimes or often take the place of potash as a fertilizer. In such cases it operates indirectly not by entering itself into the crop as a needful food to the plants but by its action on the soil, making more rapidly available some other ingredient of the soil, it may be potash, or lime or nitrogen, which is there present but exists in a comparatively inert state. It is well established that the use of soda as a fertilizer has often increased crops, but experience shows that it is commonly an uncertain and unsafe application to land. In any case it does not enrich the soil or increase its stores of plant-food, but simply facilitates their solution, consumption and, it may easily be, their waste.

As a rule soils contain more soda than potash and the frequent use of soda in fertilizers tends to exhaust and impoverish the land. If soda is to be used it is most cheaply supplied in nitrate of soda, which by its nitrogen may easily return its entire cost leaving its soda in the soil as carbonate, and if more alkali is useful, lime is vastly cheaper than soda and not a whit less efficacious, is in fact, what soda is not, an essential element of plant-nutrition, as well as the safest and surest means of fluxing the inert plant-food of the soil and putting its hoarded capital into active circulation.

2. *Sampled by Manufacturers and* 3. *Sampled by Consumers.*

2. *Sampled by Manufacturers.*

These samples were sent to the Station in compliance with the terms of the Fertilizer Law and were analyzed because no samples of the brands named were found in market by our sampling agents:

In the same table of analyses with the above is included **4416** Crocker's Ammoniated Wheat and Corn Phosphate.

This analysis was objected to by the manufacturer on account of the low per cent. of nitrogen which he claims does not fairly represent the quality of this brand.

3. *Sampled by Consumers.*

These analyses are included with those of manufacturers in the following table:—

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Special Manures, Sampled and Sent by Manufacturers.

Station No.	Name or Brand.	Manufacturer.	Sampled by	Manufacturer's Price per Ton.	Valuation per Ton.	Percentage Diff.	Nitrogen. Nitric Nitrogen.	Ammonic Nitrogen.	Organic Nitrogen.	Total. Found.	Total. Guaranteed.	Phosphoric Acid. Water-soluble.	Citrate-soluble (Reverted.)	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.
431	Special Potato Fertilizer.	G. B. Alderman, Suffield.	Manufacturer.	--	$30.03	--	.82	--	2.61	3.43	--	1.65	5.44	.60	7.69	--	7.09	--	9.47	--
423	Connecticut Wrapper Fertilizer, Pinney Formula.	Cleveland Linseed Oil Co.	"	--	33.88	--	--	--	4 38	4.38	--	--	6 24	.30	6 54	--	6.24	--	10.18	--
400	Special Tobacco Fertilizer, New England Brand.	E. Frank Coe Co., N. Y.	"	--	33.27	--	--	3.21	1.01	4.22	--	7.73	2.39	1.39	11.51	--	10.12	--	4.63	--
415	Special Connecticut Tobacco Manure.	The Crocker Fertilizer and Chemical Co.	"	--	45.31	--	.62	--	6 50	7.12	*5.75*	5.84	.76	.13	6.73	*6.0*	6.60	*5.0*	11.11	*10.0*
405	Potato Phosphate.	Cumberland Bone Phosphate Co., Boston, Mass.	"	--	24.85	--	.33	--	2.33	2.66	*2.06*	6.05	4.18	1.0	11.23	*11.0*	10.23	*9.0*	3.25	*3.0*
413	Corn Manure.	Quinnipiac Co., Boston, Mass	"	--	26.01	--	.33	--	2.80	3.13	*2.06*	5.63	5.36	1.34	12 33	*10 0*	10.99	*9 0*	1.65	*1.5*
409	Grass Manure.	Quinnipiac Co.	"	--	28.20	--	6.12	--	--	6.12	*3.91*	.22	6.10	1.23	7.55	*6.0*	6.32	*5.0*	2.90	*2.0*
407	High Grade Fertilizer for Oats and Top Dressing.	Rogers Manufacturing Co., Rockfall, Conn.	"	--	37.11	--	1.86	--	3.21	5.07	--	3.33	6.40	.40	10.13	--	9.73	--	9.60	--
398	Tobacco Special.	Walker, Stratman & Co, Pittsburgh, Pa.	"	--	24.47	--	--	--	2.48	2.48	--	7.35	2.24	.70	10.29	--	9.59	--	3.64	--
410	Grass Manure.	Williams & Clark Fertilizer Co., N. Y. City.	"	--	28.14	--	6.14	--	--	6.14	*3.91*	.17	6.03	1.21	7.41	*6 0*	6.20	*5.0*	2.93	*2.0*
416	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer and Chemical Co.	"	--	20.88	--	--	--	1.83	1.83	*2.0*	7.07	3.31	.94	11.32	*11.0*	10.38	*10.0*	1.79	*1.6*

Special Manures, Sampled and Sent by Consumers.

160	Chittenden's Complete Grass Fertilizer.	National Fertilizer Co., Bridgeport, Ct.	T. J. Stroud, Shaker Station, Ct.	$36.00	$30.10	*19.6*	trace.	2.54	1.52	4.06	*4.1*	6.05	1.45	2.47	9.97	*8.0*	7.50	*6.0*	5.53	*5.0*
214	Special Strawberry Manure.	Baker & Bro., N. Y. City.	W. H. Olcott, South Manchester, Ct.	42.50	27.71	*53.4*	--	2.13	1.10	3.23	*2.7*	4.50	1.89	1.50	7.89	--	6.39	*6.0*	8.14	*8.0*
215	Fruit and Vine Manure.	Mapes F. & P. G. Co., N. Y. City.	W. H. Olcott, South Manchester.	38.00	29.68	*28.1*	.49	.31	1.82	2.62	*1 6*	4.96	2.78	.70	8.44	*7.0*	7.74	*5.0*	10.68	*11.0*
458	Grass and Grain Fertilizer.	Leander Wilcox, Mystic.	Horatio Willard, Clinton	--	34.86	--	--	--	2.95	2.95	*2.5*	--	--	--	17.01*	*17.0*	---	--	13.38	*13.0*

* In form of Bone.

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IV. Home Mixtures.

Here are included fertilizers which have been home-made from chemicals or raw materials bought of wholesale dealers. This method of preparing mixed fertilizers is steadily growing in favor, particularly with those who study most closely the special requirements of their particular soils and crops. The formulas by which the mixtures are made are first given, followed by the analyses, page 60.

Formulas.

	4328	4329	4330	4331	4332	4333	4334
	pounds.	pounds.	pounds.	pounds.	pounds.	pounds.	pounds.
Nitrate of Soda	....	100	300	200	200	200	100
Sulphate of Ammonia	50	....	200	....	....	....	....
Dried Blood	....	....	....	....	....	....	100
Blood, Bone and Meat	....	....	2000	500	1000	700	....
Tankage	600	650	....	....	....	....	....
Bone	....	150	500	600	....	300	1200
Dissolved Bone Black	700	800	2000	600	600	700	....
Double Sulphate of potash and magnesia	650	100	500	....	....	....	....
Muriate of Potash	....	200	500	200	200	100	500
	2000	2000	6000	2000	2000	2000	1900

The cost given in each case represents the regular retail price of the raw materials delivered at the purchasers' freight station with the addition of $2.00 per ton to cover the cost of mixing. The average cost of these seven home-mixtures including cost of mixing is $36.76 and the average valuation $31.70 per ton. The percentage difference between cost and valuation is 16.0. In factory-mixed fertilizers this percentage difference has been on the average 41.3 for nitrogenous superphosphates and 33.2 for special manures during the last season.

The average valuation of these home-mixtures is therefore very much nearer their cost price than is the case with factory-mixed goods.

Most of the materials for these home-mixtures were bought at prices considerably below the regular retail rates, but for this comparison regular retail rates are employed.

Miscellaneous Fertilizers and Manures.

Cotton Hull Ashes.

In the table, page 62, are given analyses of 14 samples of Cotton Hull Ashes which show the usual variations of composition.

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Analyses of Home Mixtures.

Station No.	Name or Brand	Made by	Sampled by	Cost per ton.	Valuation per Ton.	Percentage Diff.	Nitrogen.				Phosphoric Acid.					Potash.
							Nitric Nitrogen.	Ammonic Nitrogen.	Organic Nitrogen.	Total.	Water-soluble.	Citrate-soluble. (Reverted).	Insoluble.	Total.	Available.	
4328	For Potatoes.	E. E. Burwell, New Haven	E. E. Burwell.	$33.36	$25.81	29.2	....	.45	1.43	1.88	4.77	5.36	.68	10.81	10.13	7.14
4329	For Top-dressing Grass and Grain.	E. E. Burwell, New Haven.	E. E. Burwell.	34.52	28.67	20.5	.61	....	2.01	2.62	5.97	5.98	1.35	13.30	11.95	5.75
4330	For General Use.	N. D. Platt, Milford.	Station agent.	38.69	31.07	24.5	.71	trace	2.75	3.46	6.93	2.72	.38	10.03	9.65	7.85
4331	For Potatoes.	Dennis Fenn, Milford.	" "	38.55	33.97	13.5	1.62	....	2.56	4.18	6.08	6.62	1.50	14.20	12.70	5.13
4332	For Potatoes.	Dennis Fenn, Milford.	" "	37.40	32.81	14.0	1.44	....	3.17	4.61	5.81	4.40	.66	10.87	10.21	5.37
4333	For Potatoes.	Geo. F. Platt, Milford.	" "	36.25	32.83	10.4	1.74	....	2.87	4.61	6.61	5.61	1.31	13.53	12.22	2.82
4334	For General Use.	R. H. Tucker, Saybrook.	" "	38.55	36.73	4.9	.87	....	3.24	4.11	none	8.34	5.25	13.59	8.34	12.17

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Sample **4202**, represented stock bought by Hermann Ude for $48.00 per ton. As the analysis showed the goods to be of very inferior quality, the seller agreed to take the Station valuation as the price.

Two samples were received at the Station from E. F. Brown, Berlin, who stated that they were from stock of J. C. Lincoln, Berlin, bearing tags marked "High Grade Sulphate of Potash, 90 to 95 per cent. sulphate potash."

These samples contained 22.09 and 24.98 per cent. of potash respectively, and were to all appearance cotton hull ashes.

A sample of Cotton Hull Ashes **4447**, sent by Olin Wheeler, Buckland, from stock bought of Olds & Whipple, Hartford, contained only 9.54 per cent. of potash, and 4.57 per cent. of phosphoric acid.

Messrs. Olds & Whipple being informed of the character of the goods took them back at once, and stated that the car lot would not be handled by them unless at a price corresponding to the valuation.

The price of "actual potash" in cotton hull ashes has ranged from 5.4 cents to 15.5 cents per pound, the average being 8.3 cents.

Formerly these ashes were one of the cheapest sources of available potash; they are now the most expensive source in market.

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Analyses of Cotton Hull Ashes.

Station No.	Dealer or Purchaser.	Sampled by	Soluble Phosphoric Acid.	"Reverted" Phosphoric Acid.	Insoluble Phosphoric Acid.	Potash Soluble in Water.	Cost per ton.	Valuation per ton.	Potash costs per pound in cents.
4163	G. A. Douglass, Thompsonville	C. D. Woodworth, Thompsonville	.86	7.39	.67	25.80	$37.50	$35.23	5.4
4205	Olds & Whipple, Hartford	Griswold Bros. Tariffville	2.24	10 26	.22	27.94	45.00	43.41	5.5
4302	T. Soule & Co., New Milford	Station Agent	1.46	5.08	.34	28.36	40.00	37.26	5.7
4167	Olds & Whipple, Hartford	Station Agent	2.24	7.00	1.40	24.25	40.00	35.40	6.0
4304	Olds & Whipple, Hartford	Station Agent	2.24	6.40	.65	26.16	45.00	37.46	6.7
4320	W. S. Pinney, Suffield	Samuel Barr, Suffield	1.36	6.37	.68	25.26	45.00	35.43	7.1
4290	R. A. Parker, Warehouse Point	J. B. Noble, East Windsor Hill	.56	7.62	1.25	20.54	42.00	31.12	7.9
4206	Olds & Whipple, Hartford	Station Agent	trace	5.53	.27	18.54	40 00	25.68	9.1
4201	Edward Austin, Suffield	Arthur Sikes, Suffield	.59	7.17	.38	20.66	48.00	30.44	9.5
4291	I. Luther Spencer, Suffield	F. C. Root, West Suffield	.21	6.80	1.13	21.32	40.00	30.57	11.9
4357	Edward Austin & H. A. Sheldon	F. C. Root, West Suffield	trace	4.72	1.37	12.25	38.00	18.60	13.2
4356	Edward Austin	F. C. Root, West Suffield	trace	3.56	1.28	10.78	38.00	15.75	15.5
4202	I. Luther Spencer, Suffield	F. C. Root, West Suffield	none	8.77	1.37	13.38		24.25	
4148	J. H. Hale, So. Glastonbury	J. H. Hale, So. Glastonbury	.64	4.53	1.37	25.11		34.44	

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Unleached Wood Ashes.

Station No.	Source.	Sampled and sent by	Potash Soluble in Water.	Phosphoric Acid.	Cost per ton in Car lots.
4166	Allison, Stroup & Co., New York City	J. E. Bishop, Clintonville	4.04	1.50	$11.50
4457	Allison, Stroup & Co., New York City	A. E. Atwater, Cheshire	4.70	1.28	10.50
4437	Allison, Stroup & Frost, New York City	L. S. Ellsworth, Simsbury	5.51	1.32	11.00
4186	Monroe, Lalor & Co., Oswego, N. Y.	Station Agent, from lot bought by J. F. Elwood, Greens Farms	6.20	1.34	11.50
4303	Monroe, Lalor & Co., Oswego, N. Y.	Station Agent, from lot bought by J. F. Holmes, Ridgefield	3.74	1.50	13.00
4322	F. R. Lalor, Dunnville, Ont., Canada	H. C. C. Miles, Milford	2.87	1.05	16.00*
4161	Bought in Canada	T. A. Stanley, New Britain	4.41	1.44	11.00
4450	H. K. Brainard, Thompsonville	Sumner F. Sikes, Suffield	5.43	1.50	12.00
4157	"Witch Hazel Extract Factory"	S. A. Smith, Clintonville	5.69	3.97	

* Retail, bagged.

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Unleached Wood Ashes.

In the preceding table are given nine analyses of what purport to be unleached wood ashes.

The quantity of potash in **4322** is so small as to create suspicion that the ashes have been partially leached.

The high per cent. of phosphoric acid in **4157** is probably due to the fact that the ashes came from small twigs which contain considerably more phosphoric acid than older wood.

Lime Kiln Ashes.

A sample of this material, **4121,** sent by W. G. Atkins, Forestville, was partially analyzed with the following results :

Moisture	2.81
Sand and Soil	7.74
Lime	50.87
Phosphoric Acid	.53
Potash soluble in water	1.11
Total potash	2.02

This material contains about one per cent. of soluble potash.

As a fertilizer it ranks between ordinary unleached and leached ashes.

Saltpeter Waste.

Two samples of this waste, from the works of the Hazard Powder Co., Hazardville, were sent to the Station by T. J. Stroud, Shaker Station. The analyses are as follows :

	4071	4159
Nitrogen in Nitrates		6.39
Nitrogen, organic		.22
Total Nitrogen	5.07	6.61
Potash, as Nitrate and Sulphate		25.55
Potash as muriate		1.96
Total Potash	38.70	27.51
Chlorine		1.47

This is a waste from the purification of saltpeter or nitrate of potash, used in the manufacture of gunpowder, and as the analysis shows has very considerable value as a fertilizer, though its composition is variable.

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Sheep Manure.

4442. This sample, sent by E. C. Ayer of Unionville, is stated to represent material dug from an abandoned sheep corral in the Southwest, disused because of the accumulation of dung.

Analysis.

Moisture	15.11
Nitrogen	1.37
Sand and Soil	48.29
Phosphoric Acid	1.60
Potash	1.87

This sheep manure has some value as a fertilizer, but would not pay for much transportation because nearly half its weight is due to sand.

Waste Material from the Enameling of Iron.

A sample of this material sent by Edwin Hoyt of New Canaan, with an inquiry as to its value, if any, was found to contain no nitrogen or phosphoric acid and only .26 per cent. of potash.

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REVIEW OF THE FERTILIZER MARKET.

For the Year ending November 1st, 1894.

By E. H. Jenkins.

Nitrogen.

Nitric Nitrogen.

The *wholesale* New York quotations of nitrogen in nitrate of soda have fluctuated between 11.7 cents per pound in February and 14.4 cents in May, the average quotation for October, 1894, being 12.9 cents per pound.

The average wholesale quotation for the entire year has been 13.4 cents. The averages of the monthly quotations for the past few years have been as follows:

Year	1894.	1893.	1892.	1891.	1890.
Average quotation	13.0	12.7	12.1	12.9	11.5 cents.

The *retail* ton price of nitrogen in nitrate of soda in this State during the past season has been about 16 cents per pound.

Ammonic nitrogen.

The quotations of nitrogen in this form have ruled higher than ever before and are practically prohibitory on the use of sulphate of ammonia in profitable farming.

The *wholesale* New York price of nitrogen in this form has fluctuated between 16.4 cents and 18.5 cents per pound. The average of the monthly quotations for the past year has been 17.3 cents per pound.

The corresponding averages for 1893, 1892, 1891 and 1890, were 15.7 cents, 14.5, 15.6 and 16 cents respectively.

The *retail* cash price of nitrogen in this form within Conn. has been during the past season 19½ cents per pound.

Organic nitrogen.

The *wholesale* New York quotations for nitrogen in the form of high grade and low grade blood, azotin and tankage for each month in the year are shown in detail on page 71.

While in general not as high as in 1893 they have ruled higher than for some years previous to 1893. The nitrogen of red or high grade blood which was quoted during November 1893 at 16.6 cents per pound fell gradually to 12.6 cents per pound in

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July, but has rallied sharply since. The average quotation for October was 15.1 cents per pound. Azotin and low grade blood have followed much the same course.

Dried blood, azotin and concentrated tankage scarcely appear in our retail market and accordingly retail figures cannot be given. Bone and a low grade tankage are much used by farmers as a source of nitrogen. Tobacco growers alone seem to be alive to the fact that the nitrogen of cotton seed meal is a readily available and comparatively a very cheap form of organic nitrogen.

If available to the tobacco plant it must certainly be so to any of our farm crops.

The nitrogen of cotton seed meal has cost at retail in Conn. the past season, as is shown on page 22 from 13.8 to 15.7 cents per pound. In castor pomace it has cost from 19.1 to 20.2 cents.

Phosphatic materials.

Rough bone has been uniformly quoted through the year at $19.50 per ton and bone black at the same price till within the last three months when the latter has fallen to $18.25 per ton.

Ground bone has advanced from $22.25 early in the year to $22.75 and bone meal has remained steady at $23.75.

Ground Charleston rock quoted at $8.37½ in Nov. 1893, rose to $8.50 in February but fell in August to $8.31½, and to 8.12½ in September and October.

Sulphuric acid was quoted a little lower in Oct. 1894 than earlier in the year.

Acid phosphate, was quoted at 61¼ cents per unit till April, when it fell to 59½ and 60 cents, but in August rose again and in October was quoted at 62½ cents. At this figure its available phosphoric acid costs 3.12 cents per pound *at wholesale.*

The retail price in Conn. of available phosphoric acid in dissolved bone black has been from 7.4 to 8.2 cents per pound. Acid phosphate rock, though much cheaper is not in our retail market. See pages 25 and 26.

Potash.

Muriate of Potash.

The *wholesale* New York price of potash in this form which was 3.74 cents per pound in November, 1893, fell slightly till April when it rose to 3.84 and in May to 4.13 at which price, the highest in years, it has remained up to November, 1894.

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It has been generally retailed in Conn. for about 4.1 to 4.3 cents per pound during the last season.

The Double Sulphate of Potash and Magnesia.

The *wholesale* New York price of potash in this form which was 4.33 cents per pound in November, 1893, rose to 5.04 cents per pound in May, which price, the highest in years, has held up to the date of this writing Nov. 1894.

Potash in this form has retailed in Conn. for 5.5 cents.

High Grade Sulphate of Potash.

The *wholesale* New York price of potash in this form which was 4.15 cents per pound in Nov. 1893 rose in May to 4.85 cents, at which price, the highest in years, it has since been quoted.

It has been sold at retail in Conn. for 5.6 cents per pound, the last season.

Kainit.

This article, which was quoted at $9.12½ per ton in November, 1893, rose in price with other potassium salts and was quoted in July 1894, at $11.00 and this price rules at this writing, Nov. 1894.

The market quotations given above are taken from the "Oil, Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage and some other articles are quoted and sold by the ton. The seller usually has an analysis of his stock and purchasers often control this by analysis at the time of purchase.

Sulphate of ammonia, nitrate of soda and muriate of potash are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and ammonite are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the percentage of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain 8½ units of ammonia,

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and if quoted at $2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.25 =$ $19.13.

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given:

Ammonia at	$3.00	per	unit is equivalent to nitrogen at		18.2	cts. per lb.
"	2.90	"	"	"	17.6	"
"	2.80	"	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"	"	"	15.8	"
"	2.50	"	"	"	15.2	"
"	2.40	"	"	"	14.6	"
"	2.30	"	"	"	14.0	"
"	2.20	"	"	"	13.4	"
"	2.10	"	"	"	12.8	"
"	2.00	"	"	"	12.2	"
"	1.90	"	"	"	11.6	"
"	1.80	"	"	"	11.0	"

Commercial sulphate of ammonia contains on an average 20.5 per cent. of nitrogen, though it varies considerably in quality. With that per cent. of nitrogen (equivalent to 24.3 per cent. of ammonia),

At	4.00	cents per pound.	Nitrogen costs		19.5	cents per lb.
"	3.95	"	"	"	19.3	"
"	3.90	"	"	"	19.0	"
"	3.85	"	"	"	18.8	"
"	3.80	"	"	"	18.5	"
"	3.75	"	"	"	18.3	"
"	3.70	"	"	"	18.0	"
"	3.65	"	"	"	17.8	"
"	3.60	"	"	"	17.5	"
"	3.55	"	"	"	17.3	"
"	3.50	"	"	"	17.1	"
"	3.45	"	"	"	16.8	"
"	3.40	"	"	"	16.6	"

Commercial Nitrate of Soda averages 95 per cent. of pure sodium nitrate or 16.0 per cent. of nitrogen.

If quoted at	3.0	cents per pound,	Nitrogen costs		18.8	cents per lb.
"	2.9	"	"		18.2	"
"	2.8	"	"		17.5	"
	2.7	"	"		16.9	"

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If quoted at	2.6	cents per pound,	Nitrogen costs	16.2	cents per lb.
"	2.5	"	"	15.6	"
"	2.4	"	"	15.0	"
"	2.3	"	"	14.4	"
"	2.2	"	"	13.8	"
"	2.1	"	"	13.2	"
"	2.0	"	"	12.5	"
"	1.9	"	"	11.9	"
"	1.8	"	"	11.3	"
"	1.7	"	"	10.6	"

Commercial Muriate of Potash and also High Grade (98 per cent.) Sulphate of Potash usually contain 50½ per cent. of "actual potash," or potassium oxide.

If quoted at	2.60	cents per lb.	Potassium Oxide costs	5.15	cents per lb.
"	2.50	"	"	4.95	"
"	2.40	"	"	4.75	"
"	2.30	"	"	4.55	"
"	2.25	"	"	4.45	"
"	2.20	"	"	4.35	"
"	2.15	"	"	4.25	"
"	2.10	"	"	4.15	"
"	2.05	"	"	4.06	"
"	2.00	"	"	3.96	"
"	1.95	"	"	3.86	"
"	1.90	"	"	3.76	"
"	1.85	"	"	3.66	"
"	1.80	"	"	3.56	"
"	1.75	"	"	3.46	"
"	1.70	"	"	3.36	"

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of potassium oxide.

If quoted at	1.00	cents per lb.	Potassium Oxide costs	3.77	cents per lb.
"	1.05	"	"	3.96	"
"	1.10	"	"	4.15	"
"	1.15	"	"	4.34	"
"	1.20	"	"	4.53	"
"	1.25	"	"	4.72	"
"	1.30	"	"	4.90	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since January, 1891. The price given for each month is the average of the four weekly quotations of that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 16.0 per cent. nitrogen and muriate of potash 50½ per cent. of actual potash or 80 per cent. of pure salt.

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Wholesale Prices of Fertilizing Materials.

		Cost of Nitrogen at wholesale in						Cost of Potash at wholesale in			
		Dried Blood.									
		Red. Cents per pound.	Black or low grade. Cents per pound.	Azotin or Ammonite. Cents per pound.	Concentrated Tankage. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash Cents per pound.	Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
1891.	January	11.0	10.5	11.5	....	10.9	16.5	3.58	4.53	4.33	3.69
	February	12.0	11.0	11.5	....	12.5	16.5	3 58	4.53	4.33	3.69
	March	12.5	11.9	11.5	....	14.3	16.5	3.68	4 53	4.33	3.69
	April	12.4	12.0	11.5	....	14.4	16.5	3.68	4 53	4 33	3.69
	May	12.3	11.7	11.5	....	13.6	16 0	3 68	4.53	4.33	3.69
	June	12.3	11.7	11.5	....	13.2	15.5	3.68	4 53	4.33	3.69
	July	12.2	11.6	11.5	....	12.2	15 4	3.68	4.53	4.33	3.69
	August	12.3	11.8	11.5	....	11.3	15.4	3.68	4.53	4.33	3.69
	September	12.3	12.0	11.5	....	12.2	14.8	3.68	4 53	4.33	3.69
	October	12.3	12.0	11.5	....	13.6	14.7	3 68	4.53	4.33	3.69
	November	12.6	12.3	11.5	....	13.5	14.7	3 68	4.53	4.33	3.69
	December	12.4	12.1	11.5	....	13.3	14.7	3.63	4.63	4.41	3.69
1892.	January	12.2	11.5	11.5	....	12.9	14.7	3.62	4.79	4.45	3.69
	February	11.6	11.3	11.5	....	12.0	14.7	3.64	4.77	4.48	3.69
	March	11.5	11.0	11.2	....	12.1	14.7	3.71	4.77	4.48	3.69
	April	11.8	11.3	11 2	....	11.0	14.7	3.78	4.77	4.48	3.69
	May	12.0	11.5	11.2	....	10.5	14.7	3.78	4.77	4.48	3.69
	June	11.7	11.2	11.2	....	10.	14 7	3.78	4.77	4.48	3.69
	July	12.1	11.7	11.2	....	11.1	14.7	3.78	4.77	4 48	3.69
	August	12.3	12.1	11.2	....	11.7	14.7	3.78	4.77	4.48	3.60
	September	12.4	12.0	12.0	....	12.4	14.2	3.78	4.77	4.48	3.30
	October	13.0	12.6	12.6	....	12 9	14.0	3.78	4.77	4 48	3.30
	November	14.1	13.8	13.7	....	13.7	14.0	3.78	4.77	4.48	3.30
	December	14.6	14.2	14.8	....	13.7	14.0	3.78	4.77	4.48	3.30
1893.	January	16.2	15.8	15.9	12.3	13.8	14.0	3.51	4.25	4.70	3.33
	February	18.5	18.0	17.9	15.7	14.1	14.0	3.56	4.32	4.16	3.09
	March	20.0	19.8	19.6	19.3	14.7	15.6	3.56	4.32	4.16	3.09
	April	18.0	17.7	18.1	19.3	14.6	17.1	3.56	4.32	4.16	3.09
	May	16.2	15 4	16.4	18.3	13.0	17.1	3.56	4.32	4.16	3.09
	June	14.5	14.0	14.8	14.2	11.0	15.9	3.75	4 32	4.16	3.09
	July	13.7	13.1	13.7	14.2	11.1	14.9	3.75	4.32	4.16	3.09
	August	13.5	12.1	13.9	14.2	11.4	15.6	3.75	4.25	4.16	3.09
	September	12.5	12.2	13.2	14.2	11.6	15.9	3 75	4.32	4 16	3.09
	October	16.2	15.3	15.3	17 1	11.9	16.4	3 75	4 32	4.16	3.09
	November	16.6	15.7	16.6	16.3	11.7	16.4	3.74	4.33	4.15	3.09
	December	16.1	15.3	16.1	16.3	11.3	16 4	3.74	4.33	4.15	3.09
1894.	January	15.9	14.7	16.0	15.9	12.0	16.7	3.58	4.30	4.18	3.09
	February	15.9	15.2	15.9	15.4	11.7	16.4	3.71	4.44	4.28	3.09
	March	15.5	14 6	15.5	15.4	13.0	18.5	3.71	4.44	4 28	3.09
	April	14.5	13.9	14.2	13.3	14.0	17.6	3.84	4.54	4.39	2.98
	May	14.5	13.8	14.2	12.2	14.4	16.7	4.13	5.04	4.85	3.00
	June	13.2	12 6	13.1	12.2	14.3	16.7	4 13	5 04	4.85	3.00
	July	12.6	12.6	12.9	12.2	13.8	16 8	4.13	5.04	4 85	3.00
	August	13.3	12.6	13.3	12 3	13.7	17.7	4.13	5.04	4.85	3.09
	September	15.7	14.5	15.4	12.3	13.5	18.2	4.13	5.04	4.85	3.12
	October	15.1	14.4	15.2	12.4	12 9	17.5	4.13	5.04	4 85	3.12

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THE QUANTITY OF COMMERCIAL FERTILIZERS ANNUALLY SOLD IN CONNECTICUT.

In November last a letter was sent to each manufacturer whose goods were entered for sale in this State asking for a statement of his total sales during the year ending Nov. 1, 1894, and stating that the replies would be held as strictly confidential. More than two-thirds of the manufacturers furnished the facts asked for.

The sales reported and a conservative estimate of the sales of those who did not report make it clear that the total amount of commercial fertilizers sold within the State annually cannot be less than 22,500 tons. If thirty dollars per ton is an average price, the total annual outlay for commercial fertilizers in this State is $675,000.

A similar estimate made in 1887 gave a total of 16,700 tons, costing $500,000. (Report for 1887, p. 182.)

This statement covers only factory-mixed goods, bone, mixtures of bone and salts, and fertilizer chemicals, all of which are handled by manufacturers of mixed goods. It does not, however, by any means show the total quantity of fertilizers used in the State.

It does not, for instance, include unleached wood ashes, a favorite fertilizer with fruit growers, cotton hull ashes or tobacco stems, and only a small part of the cotton seed meal which is used in the tobacco growing region in very large amount. It is impossible to estimate how much of the materials above named are annually bought.

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ON METHODS TO DETERMINE THE AVAILABILITY OF ORGANIC NITROGEN IN FERTILIZERS.

By S. W. JOHNSON and E. H. JENKINS.

(Summaries of results and the conclusions drawn from them will be found on pages *88*, *90*, *93*, *96*, *102*, *103*, *107*, *111*.)

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The work described in this paper is a continuation of what has been done by this Station on the same subject in former years of which account has been given in the following articles:—On Methods of Testing the Agricultural Value of Nitrogen in Mixed Fertilizers, Report of this Station, for 1885, pp. 115–132; On the Agricultural Value of Horn Dust and of Horn and Hoof, Report for 1886, pp. 80–89; Methods to Determine the Availability of Organic Nitrogen in Fertilizers, Report for 1893, pp. 218–237.

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The work of the present year has chiefly consisted of vegetation experiments carried on in pots, following in the main the method which has been so admirably perfected by Prof. Wagner of Darmstadt.

Further tests have also been made of the solubility of various organic forms of nitrogen in pepsin-hydrochloric acid and under putrefaction; and their results are compared with the results on the relative availability of the nitrogen as shown by vegetation experiments.

I. VEGETATION EXPERIMENTS.

Mr. W. E. Britton, Horticulturist to this Station, has had entire charge of the preparation of the seed and the artificial soil, filling the pots and caring for the crops through the whole period of growth and the success of the work is largely due to his patience and skill.

The chemical work involved has been done by the Station chemists, Messrs. Winton and Ogden.

General Scope of the Experiments of 1894.

1. Study has been made of the requirements of the maize plant with special reference to the proper supply of plant food and water when grown in pots under the conditions of our work.

2. The following materials have been compared in respect to the availability of their nitrogen, viz: nitrate of soda, dried blood, fish scrap, tankage, ground horn and hoof, cotton-seed meal, linseed meal, castor pomace, leather raw, roasted, steamed and acidified with oil of vitriol.

3. It was also sought to test the availability of organic nitrogen in twenty-seven brands of commercial fertilizers, found in the Connecticut market.

Description of the Apparatus and Method.

In some cases two, in others four, pots were used to test each form of nitrogenous matter.

These pots were filled with an artificial soil to which were added all the elements of plant food in excess of the crop requirements, excepting nitrogen.

The nitrogenous matter was added in such quantity as to supply either 0.8, 1.6, 2.4 or 3.2 grams of nitrogen.

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The availability of the nitrogen was determined by the weight of the water-free crop produced and by the quantity of nitrogen taken up by the crop.

The "crop" does not include the roots as it is impossible to separate them satisfactorily from the artificial soil.

The crops, of course, can be used as a measure of availability of nitrogen only when it is certain that the nitrogen of the fertilizer is deficient relatively to the other elements of plant food.

As we have found the apparatus and materials used to be well adapted to the purpose and as we plan to do further work with the same, a full description of them is here given.

The Vegetation House.—This house, 27 feet long by 19 feet wide and 15 feet from sills to peak, was built essentially as respects constructive details after the model designed by Prof. L. H. Bailey of the Cornell Experiment Station which is figured and described in American Gardening for February, 1893, p. 95.

Considerable modifications have been made, however, to suit the structure to its special uses. As it is designed only for summer use, no heating apparatus is provided, but ample means for ventilation have been secured. Besides a glazed door at each end, eight feet by three feet seven inches, and glazed ventilators at both sides of the ridge running the whole length of the house, which are two feet wide and are opened and closed readily by an apparatus made by Hitchings & Co., of New York, there are between the glass and the sills, four wooden ventilators on each side of the house, two of them two feet two wide by seven feet two long, and two others, two feet two by four feet eight inches. On each end are also two wooden ventilators two feet two by three feet six inches. All these ventilators are hung by hinges on the upper edges and open outwards.

Fine wire netting is fastened over all the ventilating openings within to exclude insects without interfering with the movement of the ventilators. Protection from grasshoppers and crickets is especially necessary. Wire netting doors make it possible also to leave the sash doors open for ventilation when desired. The construction is nearly as slight as is consistent with safety and offers very little obstruction to sunlight.

The ridge of the house and the three benches on which the pots stand run nearly north and south.

Observations were made through the season at 9 A. M., 12 M. and 5 P. M. to determine how much the temperature in the shade

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within the house differed from the air temperature in the shade without.

At the times of ten single observations the temperature within the house was lower than without, but at all other times of observation the reverse was the case.

The greatest observed difference of temperature was ten degrees Fahr.

The greatest difference between the mean of the three daily observations without and within the house was 7.3 degrees Fahr.

The average daily difference was 3.6 degrees Fahr.

Water Supply.—In one corner of this vegetation house was placed a circular tank 23 inches in diameter and 39 inches deep made of heavy "galvanized" iron and painted inside with asphalt. A battery of Pasteur-Chamberland filters, attached to the city water service pipes supplied very pure water which was stored in this tank for use in the experiment.

The general appearance and arrangement of the house are shown in the accompanying plates.

Plate I shows the appearance of the house seen from the southwest. The ventilators at the sides and in the peak and the sash doors in the ends, are all opened, the netting doors being closed. It was not found necessary to use the ventilators in the ends of the building during the season.

The iron pipes which support the sash bars and give rigidity to the structure are seen within. The arrangement of these supports is described in Prof. Bailey's paper already referred to.

Plate II shows the interior plan. A and B are the north and south end doors. C, D and E, are the three benches which carry the vegetation pots. Table C is 21 feet long by 3¾ feet wide, table D 19⅓ feet long by 3 feet 2 inches wide, and table E is 23 feet long by 3¾ feet wide. The tops of these benches are 16 inches above the level of the top of the sills and 15 inches below the level of the glass in the sides of the building. F is the water tank and H a faucet from which with rubber hose water may be drawn for watering the floor and tables when desired.

Pots.—The pots used were made of "galvanized" iron, wired on the upper edge. They were eight inches in diameter, twelve inches deep, the bottom slightly concave, and in the center of the bottom was a hole with a collar ¾ of an inch in diameter, which could be closed with a rubber stopper. Each pot was supported on three iron legs, so that the lowest point of the collar

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PLATE I. Vegetation House.

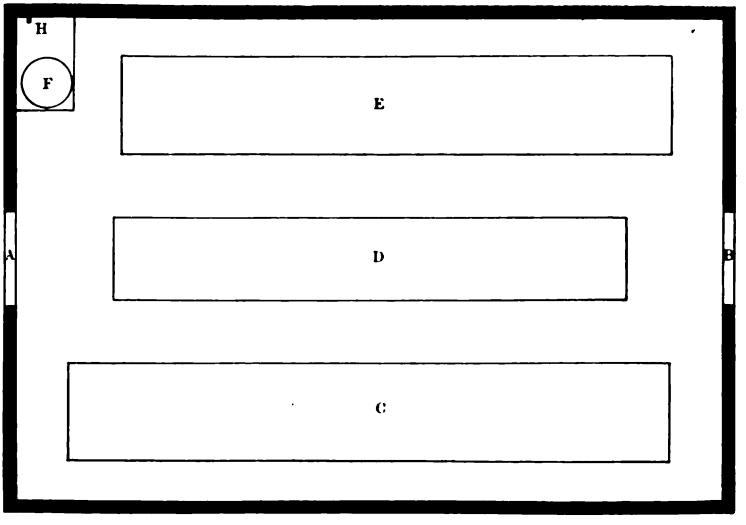

PLATE II. Interior Plan of Vegetation House.

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referred to was two and a half inches above the platform on which the pot stood. The general appearance of the pots may be seen by reference to the plates facing page 104.

The Artificial Soil consisted of sifted anthracite coal ashes, to which three per cent. of peat moss had been added. This peat moss, we are informed is imported for stable bedding. It was sifted, and only that part was used which passed a sieve with about six meshes to the inch. This peat has a slight acid reaction and on digestion with water continued to give up acid for 48 hours. The total quantity thus extracted per gram of peat moss, neutralizes about .1144 grams of barium hydrate. Distilled with magnesia, four grams yielded a bare trace of ammonia. The peat moss contains $\frac{64}{100}$ of one per cent. of nitrogen. The coal ashes, fresh from the Station steam heater, were sifted through a wire sieve having square meshes, four to the inch. The ashes were perfectly neutral in reaction, and contained $\frac{6}{100}$ of one per cent. of nitrogen.

For the experiments of 1893, described in the Report for that year, p. 230, a mixture of five p. c. peat moss and 95 p. c. coal ashes was used as soil. Observations then made indicated that a smaller proportion of peat would give physical conditions quite as favorable to vegetation and led us to reduce the quantity this year to three per cent.

Fertilizer Ingredients.

Besides nitrogen, which was supplied in different forms and varying quantities, there was added to the soil of every pot a definite quantity of calcium carbonate, potassium sulphate, dicalcium phosphate and "concentrated phosphate."

The complete analyses of these materials follow:

TABLE I. ANALYSES OF FERTILIZERS USED IN THE EXPERIMENTS.

	Calcium Carbonate.	Potassium Sulphate.	Dicalcium Phosphate.	"Concentrated" Phosphate.
Sand and Silica	- - -	.36	----	6.26
Oxide of iron and alumina	----	.70	----	38.37
Lime (CaO)	53.18	.55	35.49	.30
Magnesia	.90	2.88	----	.12
Potash (K_2O)	----	46.30	----	----
Soda	----	.59	----	.42
Phosphoric Acid (P_2O_5)	----	----	42.36	45.61
Sulphuric Acid (SO_3)	----	43.34	----	.21
Chlorine	----	1.80	----	trace
Carbonic Acid (CO_2)	43.82	----	----	----
Water	2.10	3.44	22.15	8.85
	100.00	99.96	100.00	100.14

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With the exception of Nos. 36 to 49, both inclusive, the soil of every pot received 15 grams of calcium carbonate, 4.4 grams of potassium sulphate, 1.5 grams of dicalcium phosphate and 1.2 grams of concentrated phosphate.

Hence, with the exceptions noted above, the soil of each pot received, in addition to what plant food the ashes themselves contained, the following quantities of mineral ingredients :

Potash (K_2O)	2.04	grams.
Soda	.03	"
Lime (CaO)	8 54	"
Magnesia (MgO)	.27	"
Oxide of iron and alumina	.49	"
Phosphoric Acid (P_2O_5)	1.18	"
Sulphuric Acid (SO_3)	1.91	"
Chlorine	.08	"

The object of adding calcium carbonate was to maintain in the soil the mild alkalinity essential to the process of nitrification.

Seed.—The seed maize used was Hickox Improved Sweet Corn, raised in Milford, Conn. about nine miles from the Station.

By means of concentrated sugar solutions at a temperature of 24°C. there were separated those kernels which had an apparent specific gravity between 1.246 and 1.216.

After these were thoroughly and rapidly washed and air dried the separate kernels were weighed, reserving for experiment only those which weighed between .290 and .320 gram each, this being about the medium weight.

This work was deemed necessary in order to secure plants of equal vigor and fairly comparable. Unfortunately the seed corn of 1893 was of poor quality and the plants were not altogether satisfactory.

Filling and planting Vegetation Pots.—After thorough washing and drying, each pot was fitted with a piece of wire gauze over the hole in the bottom and with a glass tube of about $\frac{1}{8}$ inch bore, reaching to the bottom of the pot and projecting about $\frac{1}{2}$ inch above its upper rim. Washed fine quartz gravel was poured in, till the weight of the pot and contents was exactly 2721 grams (6 pounds). The layer of gravel was from $\frac{1}{2}$ to $\frac{3}{4}$ inch deep in the shallowest part.

Into each pot were next poured 4536 grams (ten pounds) of the artificial soil which had been thoroughly intermixed by hand with

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the fertilizers already referred to, and with the weighed amount of organic nitrogen designed for that pot, the whole charge being pressed down to the same level in all the pots.

To each pot was then added 1446 grams (3 pounds and 3 ounces) of water which represented about 40 per cent. of the water-holding capacity of the soil.

The maize seed after soaking twelve hours in water was placed in a germinating apparatus.

On the 15th and 16th of June as the maize sprouted, three healthy looking seedlings were placed in each pot on the surface of the soil and equidistant from each other.

They were covered with 340 grams (12 ounces) of the mixture of peat and ashes which buried the seeds about three-quarters of an inch deep.

To 150 grams of rich garden soil were added 1500 c.c. of water and the whole shaken together. After the sand, etc., had settled, 15 c.c. of the turbid, supernatant liquid were added to each of the pots excepting Nos. 28 to 35 both inclusive. It was intended in this way to make more certain of the presence of nitrifying organisms within the soil.

On June 19th nearly all the plants had come up and the pots were removed to the vegetation house.

Care of the Experiments during Growth.

By frequent weighing and watering the water content of the soil in all the pots, excepting Nos. 14 to 21, both inclusive, was kept between 30 and 50 per cent. of the water-holding capacity of the soil. In vegetation experiments with natural soils a much higher percentage is adopted, but because the water-holding capacity of this artificial soil is greater than that of ordinary natural soils the lower figure was thought to be adequate. The relative position of the pots was changed from time to time in order to equalize as far as possible their exposure to light and heat.

In spite of the care exercised in selecting seed it immediately appeared that a part of the seedlings were incapable of growth.

On June 26, one plant was missing in each of the following pots. Nos. 1, 13, 24, 66, 72, 81, 96, 103, 115, 129, 145, 149. Two plants were missing in pots 21 and 26. The decaying seeds were removed and new ones planted which in all cases lived.

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On July 2, one plant in No. 127 appeared as if badly burned. One plant in pot 134 was badly diseased, made no growth and was removed.

Each of the following pots had one, more or less abnormal, stunted plant; Nos. 1, 7, 23, 36, 47, 51, 114, 126, 130 and 134. Some of these afterwards grew to good size but never equaled the others in the same pot. It was noted that where a single plant was feeble and small another in the same pot would grow to be correspondingly larger, as if it took to itself the nitrogen which the other did not appropriate.

On July 18th, it was thought that the pots were standing too close to permit full development of all the plants. The foliage of the plants in certain pots was becoming pale green as if light were deficient. Those pots which had the larger supply of nitrogen, Nos. 7, 8, 12, 13, 24, 25, 26, 27, 104, 105, 108, 109, 112, 113, 116, 117, 125, 126, 130, 141, were therefore removed to a green house used in last year's experiments.

July 23d, those plants which received the smallest quantities of nitrogen, within a few days became very appreciably lighter in color, as if this date marked the time when nitrogen-hunger, or more properly nitrogen-starvation had set in.

On July 20, 4.9535 grams of nitrate of soda, equivalent to .8 gram nitrogen were added to pots 11 and 13.

July 30, the first staminate flower appeared, in pot 30.

Aug. 1. The tips of leaves were brown and dry on many plants among those which had received least nitrogen.

Aug. 2. By accident one plant in pot 116 was broken off close to the ground.

Aug. 11. Nearly all the plants which received the smallest quantity of nitrogen had very light green foliage, in sharp contrast with the others and were evidently suffering for lack of nitrogen. There were staminate flowers on two-thirds of the plants.

Aug. 13. Pistillate flowers first appeared on the plants of pots 12 and 26.

Aug. 16. The following pots were sent to the laboratory for harvest and chemical examination of the crops: Nos. 3, 51, 53, 55, 57, 59, 62, 64, 66, 68, 70, 72, 74, 76, 79, 81, 83, 85, 87, 89, 93, 95, 97, 98, 100, 118, 119, 121, 135, 138, 142, 146.

Aug. 17. The pots which were removed on July 18th were brought back to the vegetation house.

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Aug. 28. The following pots were sent to the laboratory for harvest and chemical examination of the crops: Nos. 50, 52, 54, 56, 58, 60, 63, 65, 67, 69, 71, 73, 75, 77, 78, 80, 82, 84, 86, 88, 91, 92.

Aug. 27 to 31, all the pistillate flowers were pollinated by hand daily.

Sept. 18. All the pots remaining in the vegetation house were sent to the laboratory for harvest and chemical examination of the crops.

None of these plants reached normal size or development because in all cases there was a deficiency of nitrogen or of other elements of plant food.

In each of thirty-eight of the crops there were one or more ears, in all cases small or abortive. The following statement gives the number of ears which contained kernels of corn.

The crops in the following pots each had one seed-bearing ear: 5, 6, 8, 12, 13, 15, 17, 23, 24, 33, 104, 106, 107, 117, 124, 128, 130, 148.

Each of the following carried two seed-bearing ears:—1, 7, 9, 10, 11, 19, 21, 25, 27, 29, 30, 105, 108, 109, 113, 126, 141.

The following had each three ears with seed:—26, 112, 125.

In pots 29 and 108 both ears were on one plant.

Determination of Dry Weight of Crops and of Nitrogen in them.

The crops were harvested as soon as they were brought to the laboratory. The three plants from each pot were cut off close to the surface of the soil; then cut into small pieces about half an inch long, and dried in a large drying oven at a temperature below 100° C. After drying, each crop was ground without any mechanical loss in a feed mill and allowed to stand exposed to the air for twenty-four hours. It was then weighed on a chemical balance, sensitive to a fraction of a milligram, and securely bottled.

Duplicate portions of the air-dry material (two grams in each), contained in weighing bottles were dried to constant weight at a temperature of 100° C.

From the result was calculated the weight of the water-free crop.

Nitrogen was also determined in duplicate portions.

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In the following table, and preliminary to a discussion of the results of these vegetation experiments, are given all the data regarding the nitrogen supply and the quantities of water-free substance and of nitrogen harvested.

The following explanations are referred to by small numerals in their appropriate places in the table.

[1] The nitrogen was added August 6th. At that time the appearance of the crop was like that of crops in pots 2, 3, and 4.

[2] .8 gram nitrogen added at planting time and .8 on July 20.

[3] .8 gram nitrogen was added at planting, and .8 on July 20 and also on Aug. 6th.

[4] The water in the pot was kept between 80 and 60 per cent. of the water-holding capacity of the soil. See p. 87.

[5] The water in the pot was kept between 70 and 50 per cent. of the water-holding capacity of the soil. See p. 87.

[6] The water in the pot was kept between 60 and 40 per cent. of the water-holding capacity of the soil. See p. 87.

[7] The water in the pot was kept between 80 and 40 per cent. of the water-holding capacity of the soil. See p. 87.

[8] No soil extract was added to the soil.

[9] 100 grams of garden soil were added to the soil.

[10] Normal quantity phosphoric acid, ½ normal quantity of potash.

[11] " " " " ¾ " " "

[12] " " " " 1½ " " "

[13] " " " " 1¾ " " "

[14] " " potash, ½ normal quantity phosphoric acid.

[15] " " " ¾ " " " "

[16] " " " 1½ " " " "

[17] " " " 1.7 " " " "

[18] 1½ normal quantity potash, 1.7 normal quantity of phosphoric acid.

[19] 1½ " " " and " " " "

[20] 1¾ " " " and " " " "

[21] Normal quantity potash, 1½ " " " "

[22] " " " 1.7 " " " "

[23] 1½ normal quantity potash, 1.7 " " " "

The data given in this table may now be discussed in detail.

The basis of comparison of the crops and of the nitrogen in them is the *increase of crop* and of assimilated nitrogen produced by the several fertilizers over what was produced on the artificial soil without any nitrogenous fertilizer (pots 2, 3, and 4). This for brevity is referred to in the following discussion as "Crop Increase," and "Nitrogen Increase."

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TABLE II.—VEGETATION EXPERIMENTS OF 1894. DATA REGARDING FERTILIZERS AND CROPS HARVESTED.

No. of Pot.	Nitrogen supplied		The Crop.			The Nitrogen in the Crop.			
	In form of	Quantity of nitrogen supplied. (grams.)	Weight of air-dry Crop (exclusive of roots). (grams.)	Weight of water-free Crop. (grams.)	Increase of Crop over Crop of Pots 2, 3 and 4. (grams.)	Per cent. of nitrogen in the air-dry Crop.	Total nitrogen of Crop (exclusive of roots). (grams.)	Increase of nitrogen of Crop over that of Crop in Pots 2, 3 and 4.	Of 100 parts of nitrogen in the fertilizer there were recovered in the Crop. (parts.)
1	----------	.8 [1]	35.49	32.76	29.60	1.31	.465	.448	----
2	----------	none	3.54	3.23	------	.48	.017	-----	----
3	----------	none	2.90	2.60	------	.52	.015	-----	----
4	----------	none	3.91	3.64	------	.46	.018	-----	----
5	Ground Horn and Hoof	.8	82.97	74.01	70.85	.37	.307	.290	36.3
6	" " " "	1.6	130.42	118.92	115.76	.43	.561	.544	33.3
7	" " " "	2.4	140.90	128.89	125.73	.72	1.015	.998	41.6
8	" " " "	3.2	143.63	132.38	129.22	.89	1.278	1.261	39.4
9	Nitrate of Soda	.8	109.70	99.88	96.72	.35	.384	.367	45.9
10	" "	1.6	154.77	140.87	137.71	.56	.867	.850	53.2
11	" "	.8+.8 [2]	144.86	131.94	128,78	.55	.797	.780	48.8
12	" "	2.4	116.57	107.18	104.02	1.18	1.376	1.359	56.6
13	" "	.8+.8+.8 [3]	124.43	113.42	110.26	1.23	1.531	1.514	63.1
14	Dried Blood	.8 [4]	88.29	80.01	76.85	.37	.327	.310	38.8
15	" "	1.6 [4]	164 22	151.44	148.28	.38	.624	.607	38.0
16	" "	.8 [5]	104.89	96.66	93.50	.34	.357	.340	42.6
17	" "	1.6 [5]	160.95	145.03	141.97	.37	.596	.579	36.2
18	" "	.8 [6]	92.44	85.75	82.59	.37	.342	.325	40.7
19	" "	1.6 [6]	136 39	124.14	120.98	.44	.600	.583	36.5
20	" "	.8 [7]	100.57	91.95	88.79	.37	.372	.355	44.5
21	" "	1.6 [7]	142.35	131.68	128.52	.42	.598	.581	36.4
22	Dried Blood	.8	85.63	76.56	73.40	.39	.334	.317	39.7
23	" "	1.6	143.87	129.48	126.32	.42	.604	.587	36.7
24	" "	2.4	150.09	135.48	132.32	.62	.931	.914	38.1
25	" "	2.4	155.98	141.29	138.13	.65	1.030	1.013	42.2
26	" "	3.2	141.43	130.12	126.96	.91	1.287	1.270	40.2
27	" "	3.2	170.40	153.35	150.19	.74	1.261	1.244	38.7
28	Dried Blood	.8 [8]	87.47	79.71	76.55	.35	.306	.289	38.3
29	" "	1.6 [8]	147.28	136.81	123.65	.45	.663	.646	41.4
30	" "	2.4 [8]	150.52	138.58	135.42	.66	.993	.976	41.6
31	Dried Blood	.8 [9]	80.57	73.31	70.15	.44	.354	.337	44.3
32	" "	1.6 [9]	129 94	117.83	114.67	.42	.546	.529	34.1
33	" "	2.4 [9]	160.53	146.93	143.77	.65	1.043	1.026	43.5
34	" "	none [9]	6.25	5.70	2.54	.36	.023	.006	----
35	" "	none [9]	3.73	3.42	.26	.42	.016	-----	----
36	Dried Blood	1.6 [10]	131.48	120.45	117.29	.40	.526	.509	32.9
37	" "	1.6 [11]	128.73	118.64	115.48	.41	.528	.511	33.0
38	" "	1.6 [12]	123.43	112.83	109.67	.46	.568	.551	35.5
39	" "	1.6 [13]	140.21	127.69	124.53	.40	.561	.544	35.1

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TABLE II.—VEGETATION EXPERIMENTS OF 1894. DATA REGARDING FERTILIZERS AND CROPS HARVESTED.—*Continued.*

No. of Pot.	Nitrogen supplied		The Crop.			The Nitrogen in the Crop.			
	In form of	Quantity of nitrogen supplied. (grams.)	Weight of air-dry Crop (exclusive of roots). (grams.)	Weight of water-free Crop. (grams.)	Increase of Crop over Crop of Pots 2, 3 and 4. (grams.)	Per cent. of nitrogen in the air-dry Crop.	Total nitrogen of Crop (exclusive of roots). (grams.)	Increase of nitrogen of Crop over that of Crop in Pots 2, 3 and 4.	Of 100 parts of nitrogen in the fertilizer there were recovered in the Crop. (parts.)
40	Dried Blood	1.6^{14}	122.68	110.19	107.03	.42	.515	.498	32.2
41	" "	1.6^{15}	139.75	128 93	125.77	.40	.559	.542	34.9
42	" "	1.6^{16}	135.41	125.92	122.76	.43	.582	.565	36.4
43	" "	1.6^{17}	143.75	132.54	129 38	.45	.647	.630	40.4
44	Dried Blood	1.6^{18}	134.83	121.97	118.81	.41	.553	.536	34.6
45	" "	1.6^{19}	91.84	82 68	79.52	.35	.321	.304	20.1
46	" "	1.6^{20}	98.94	90.56	87.40	.32	.317	.300	19.4
47	Dried Blood	1.6^{21}	82.80	75 74	72.58	.42	.348	.331	21.7
48	" "	1.6^{22}	92.92	85.07	81.91	.35	.325	.308	20.3
49	" "	1.6^{23}	97.87	89.85	86.69	.34	.333	.316	20.8
50	I Commercial Mixed Fertilizer	1.6	114.12	101.81	98 65	.37	.422	.405	26.4
51	II " " "	.8	55.32	50.59	47.43	.41	.227	.210	26.0
52	II " " "	1.6	121.42	107.99	104.83	.36	.437	.420	27.3
53	III " " "	.8	66.47	61.08	57.92	.39	.259	.242	32.4
54	III " " "	1.6	134.65	118.67	115.41	.39	.525	.508	32.8
55	IV " " "	.8	65.84	60.19	57.03	.40	.263	.246	32.9
56	IV " " "	1.6	114 88	101 99	98.83	.43	.494	.477	30.9
57	V " " "	.8	54 30	49.50	46.34	.41	.220	.203	27.5
58	V " " "	1.6	113 44	99.90	96.74	.38	.431	.414	27.0
59	VI " " "	.8	66 27	61.03	57 87	.39	.259	.242	32.4
60	VI " " "	1.6	126.55	111.17	108.01	.42	.531	.514	33.2
61	VII " " "	1.6	102 70	90.79	87.63	.39	.401	.384	25.0
62	VIII " " "	.8	54.63	49.64	46.48	.53	.290	.273	36.2
63	VIII " " "	1.6	130 54	112.03	108.87	.39	.509	.382	31.8
64	IX " " "	.8	69.46	63.69	60.53	.43	.295	.278	36.9
65	IX " " "	1.6	147.31	127.63	124.47	.38	.560	.543	35.0
66	X " " "	.8	65.65	60.71	57 55	.44	.289	.272	36.1
67	X " " "	1.6	146.91	129.84	126.68	.38	.558	.541	34.9
68	XI " " "	.8	50.23	45.84	42.68	.44	.221	.204	27.6
69	XI " " "	1.6	109.90	98 69	95.53	.38	.418	.401	26.1
70	XII " " "	.8	51.72	47.07	43.91	.42	.217	.200	27.1
71	XII " " "	1.6	107.80	93.25	90.09	.36	.388	.371	24.2
72	XIII " " "	.8	67.22	61.66	58.50	.41	.276	.259	34.5
73	XIII " " "	1.6	156 39	137.09	133.93	.39	.610	.593	38.1
74	XIV " " "	.8	59.04	54.37	51.21	.38	.224	.207	28.0
75	XIV " " "	1.6	118.88	103.23	100.07	.38	.452	.435	28.2
76	XV " " "	.8	65.22	59.03	55 87	.43	.280	.263	35.0
77	XV " " "	1.6	133 23	115.87	112 71	.40	.533	.516	33.3
78	XVI " " "	1.6	75.42	64.72	61 56	.38	.287	.270	18.0
79	XVII " " "	.8	82.89	75.62	72.46	.43	.356	.339	44.5
80	XVII " " "	1.6	145.49	128.76	125.60	.39	.568	.551	35.0
81	XVIII " " "	.8	40.96	37 61	34.45	.46	.188	.171	23.5
82	XVIII " " "	1.6	106.20	91.94	88.78	.37	.393	.376	24.6

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TABLE II.—VEGETATION EXPERIMENTS OF 1894. DATA REGARDING FERTILIZERS AND CROPS HARVESTED.—*Continued.*

No. of Pot.	Nitrogen supplied		The Crop.			The Nitrogen in the Crop.			
	In form of	Quantity of nitrogen supplied. (grams.)	Weight of air-dry Crop (exclusive of roots). (grams.)	Weight of water-free Crop. (grams.)	Increase of Crop over Crop of Pots 2, 3 and 4. (grams.)	Per cent. of nitrogen in the air-dry Crop.	Total nitrogen of Crop (exclusive of roots). (grams.)	Increase of nitrogen of Crop over that of Crop in Pots 2, 3 and 4.	Of 100 parts of nitrogen in the fertilizer there were recovered in the crop. (parts.)
83	XIX Commercial Mix'd Fertilizer	.8	56.98	52.33	49.17	.44	.251	.234	31.4
84	XIX " " "	1.6	138.76	122.66	119.50	.41	.569	.552	35.6
85	XX " " "	.8	70.23	63.91	60.75	.39	.274	.257	34.2
86	XX " " "	1.6	127.50	110.51	107.35	.42	.636	.519	33.5
87	XXI " " "	.8	64.70	59.53	56.37	.44	.285	.268	35.6
88	XXI " " "	1.6	132.75	116.13	112.97	.39	.518	.501	32.4
89	XXII " " "	.8	71.09	64.45	61.29	.40	.284	.267	35.5
90	XXII " " "	1.6	141.80	125.29	122.13	.39	.553	.536	34.6
91	XXIII " " "	1.6	100 33	86.65	83.49	.37	.371	.354	23.2
92	XXIV " " "	1.6	109.65	96.99	93.83	.34	.373	.356	23.3
93	XXV " " "	.8	52.73	48.34	45.18	.42	.222	.205	27.8
94	XXV " " "	1.6	123.71	108.51	105.35	.36	.445	.428	27.8
95	XXVI " " "	.8	63.59	58.41	55.25	.46	.293	.276	36.6
96	XXVI " " "	1.6	128.37	115.26	112.10	.41	.526	.509	32.9
97	XXVII " " "	.8	45.88	41.82	38.66	.43	.197	.180	24.6
98	XXVIII " " "	.8	65.61	59.61	56.45	.42	.276	.259	34.5
99	XXVIII " " "	1 6	123.27	109.83	106.67	.40	.493	.476	30.8
100	XXIX " " "	.8	68.17	62,31	59.15	.39	.266	.249	33.2
101	XXIX " " "	1.6	141.38	124.26	121.10	.45	.636	.619	39.7
102	A. Castor Pomace	.8	95.38	86 99	83.83	.33	.315	.298	39.3
103	" " "	1.6	107.40	97.84	94.68	.47	.505	.488	31.6
104	" " "	2.4	136.93	127.04	123.88	.69	.945	.928	39.0
105	" " "	3.2	115.98	107.49	104.33	.99	1.148	1.131	32.8
106	B. Castor Pomace	.8	89.97	83.48	80.32	.39	.351	.334	43.9
107	" " "	1.6	151.13	140.10	136.94	.45	.680	.663	42.5
108	" " "	2.4	153.28	140.91	137.75	.79	1.211	1.194	50.5
109	" " "	3.2	166.53	155.17	152.01	.90	1.499	1.482	46.8
110	Cotton Seed Meal	.8	82.45	74.81	71.65	.40	.330	.313	41.2
111	" " "	1.6	125.37	116.36	113.20	.47	.589	.572	36.8
112	" " "	2.4	152.21	140.23	137.07	.74	1.126	1.109	47.0
113	" " "	3.2	156.37	143.55	140.39	.74	1.157	1.140	36.1
114	Dry Ground Fish	.8	80.20	73.21	70.05	.37	.297	.280	37.1
115	" " "	1.6	123.38	114.74	111.58	.43	.531	.514	33.2
116	" " "	2.4	114.74	109.12	105.96	.81	.929	.912	38.7
117	" " "	3.2	145.47	132.60	129.44	.73	1.062	1.045	33.2
118	XXX Comm'cial Mixed Fertilizer	------	2.79	2.55	-----	.78	.022	.005	---
119	XXXI " " "	.8	90.25	81.89	78.73	.41	.366	.349	45.8
120	XXXI " " "	1.6	149.83	133.02	129.86	.46	.689	.672	44.1
121	XXXII " " "	.8	60.52	55 25	52.09	.45	.272	.255	34.0
122	XXXII " " "	1 6	138.26	124.49	121.33	.39	.539	.522	33.7

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TABLE II.—VEGETATION EXPERIMENTS OF 1894. DATA REGARDING FERTILIZERS AND CROPS HARVESTED.—*Continued.*

No. of Pot.	Nitrogen supplied		The Crop.			The Nitrogen in the Crop.			
	In form of	Quantity of nitrogen supplied. (grams.)	Weight of air-dry Crop (exclusive of roots). (grams.)	Weight of water-free Crop. (grams.)	Increase of Crop over Crop of Pots 2, 3 and 4. (grams.)	Per cent of nitrogen in the air-dry Crop.	Total nitrogen of Crop (exclusive of roots). (grams.)	Increase of nitrogen of Crop over that of Crop in Pots 2, 3 and 4.	Of 100 parts of nitrogen in the fertilizer there were recovered in the Crop. (parts.)
123	Tankage	.8	72.22	65.35	62.19	.39	.282	.265	35.2
124	"	1.6	137.29	125.20	122.04	.43	.590	.573	36.9
125	"	2.4	124.90	114 61	110.45	.82	1.024	1.007	42.7
126	"	3.2	99.70	92.09	88.93	1.08	1.077	1.060	34.0
127	Linseed Meal	.8	84.50	81.31	78.15	.39	.330	.313	41.2
128	" "	1.6	127.07	116.27	113.11	.50	.635	.618	39.7
129	" "	2.4	139.75	129.58	126.42	.54	.755	.738	31.5
130	" "	3.2	124.48	114.93	111.77	.73	.909	.892	28.1
131	XXXIII Com'cial Mix'd Fertilizer	.8	74.44	68.09	64 93	.35	.261	.244	32.6
132	XXXIV " " "	.8	85.87	78.16	75.00	.39	.335	.318	41.9
133	Home Mixed Fertilizer	.8	87.43	80.37	77.21	.37	.324	.307	40 5
134	" " "	.8	89.00	80.94	77.78	.33	.294	.277	36.8
135	Raw Leather	.8	2.48	2.26	-----	.55	.014	----	1.7
136	" "	1.6	1.96	1.78	-----	.45	.009	----	0.5
137	Dissolved Leather	.8	83.16	73.26	70.10	.37	.308	.291	38.5
138	Garbage and Leather	.8	27.83	25.67	22.51	.50	.139	.122	17.4
139	" " "	1.6	73.72	65.26	62.10	.35	.258	.241	16.1
140	" " "	2.4	94.07	86.16	83.00	.35	.329	.312	13.7
141	" " "	3.2	103.84	95.69	92.53	.54	.561	.544	17.5
142	Steamed Leather	.8	10.34	9.48	6 32	.46	.047	.030	5.9
143	" "	1.6	14.21	12.89	9.73	.37	.053	.036	3.3
144	" "	2.4	27.60	24.16	21.00	.32	.088	.071	3.7
145	" "	3.2	28.91	26.38	23.22	.40	.116	.099	3.6
146	Roasted Leather	.8	8.20	7.40	4.24	.49	.040	.023	5.0
147	" "	1.6	17.25	15.19	12.03	.41	.071	.054	4.4
148	Dried Blood	1.6	106.38	97.79	94.63	.43	.457	.440	28.6
149	" "	1.6	135 35	124.40	121.24	.37	.501	.484	31.3

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Influence of the Water Content of the Soil during growth, on Crop Production.

(Pots 14, 16, 18, 22, 20 and 15, 17, 19, 23, 21.)

The "water-holding capacity of the soil" was determined as follows:

Each pot when filled for experiment held 4876 grams (10¾ pounds) of artificial soil.

Water was poured on the surface of the soil of a single pot till the soil was saturated and water ran off through the drainage tube. When the draining ceased, the pot and contents were weighed.

It appeared that the 4876 grams of soil would hold 3892 grams ($8\frac{17}{100}$ pounds) of water.

In following paragraphs, for brevity, the water supply is described as "80 to 60 per cent." etc. This signifies that the pot referred to never contained more than 80 per cent. nor less than 60 per cent. of 3892 grams of water, i. e., its water-content never exceeded 3113 grams (110 ounces) nor fell below 2335 grams (82 ounces).

The pot was placed on the scales from day to day and whenever its weight showed that it contained but 82 ounces of water enough was added to bring the amount up to 110 ounces.

About one-half of this water was carefully distributed over the surface of the soil and the remainder was poured through the tube to the bottom of the pot.

The results of the observations on the Water Content of the Soil may be tabulated for comparison as follows:

Table III.—Influence of Water Supply on Crop Production.

Nitrogen Supply, .8 Gram in Dried Blood.

No. of Pot.	Water Supply.	Crop Increase. grams.	Nitrogen Increase. gram.
14	80—60 per cent.	76.9	.310
16	70—50 "	93.5	.340
18	60—40 "	82.6	.325
22	50—30 "	73.4	.317
20	80—40 "	88.8	.355

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NITROGEN SUPPLY, 1.6 GRAMS IN DRIED BLOOD.

15	80—60 per cent.	148.3	.607
17	70—50 "	141.9	.579
19	60—40 "	121.0	.583
23	50—30 "	126.3	.587
21	80—40 "	128.5	.581

With .8 gram of nitrogen the largest crop increase was secured when the quantity of water in the soil was kept between 70 and 50 per cent. More water, 80-60 per cent. produced less crop. Less water, 60 to 40 per cent. and 50 to 30 per cent. also lessened production. When the water was allowed to fluctuate between 80 and 40 per cent. the crop was a little less than when between 70 to 50 per cent. of water was used.

The same is true of the nitrogen increase, except that the largest quantity was in the crop which received from 80 to 40 per cent. of water.

From 50 to 60 per cent. of water or else from 80 to 40 per cent. would seem to have been the quantity most favorable, with .8 gram of nitrogen in dried blood.

When 1.6 grams of nitrogen in form of blood were applied, the largest crop and the largest quantity of nitrogen was got with 80 to 60 per cent. of water. Somewhat less crop increase was got, with a water content of 70 to 50 per cent.; but 60 to 40, 50 to 30, and 80 to 40 per cent. gave decidedly less crop. It is noteworthy however that the quantity of nitrogen in these crops was nearly the same, despite the fluctuations in the water content of the soil and in the weights of crop.

With 1.6 grams of blood nitrogen, 80-60 per cent. of water appears necessary to secure the maximum effect. With smaller quantities of water however nearly the same amount of nitrogen entered the crop, but dry substance was found in less proportion.

These observations indicate that the quantity of water used in the other experiments of this year (50 to 30 per cent.) may not have been enough to bring the nitrogen of the fertilizers to its full efficiency in crop production.

They also indicate that as the nitrogen supply is increased (the quantities used were .8, 1.6, 2.4, and 3.2) the efficiency of the nitrogen in crop production may have been more and more seriously diminished by deficiency of water.

They further show that a reduction of yield on account of the deficiency of water is not necessarily followed by a reduction in the quantity of nitrogen in the crop.

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Where more than .8 gram of nitrogen were used as fertilizer, deductions based on CROP INCREASE are unsafe, because it is probable that the water supply was not in excess of crop requirement.

Where more than 1.6 grams of nitrogen were used as fertilizer, deductions based on NITROGEN INCREASE are probably unsafe.

Was Garden Soil or its Extract helpful to the Assimilation of Organic Nitrogen?

(Pots 22, 28, 31, 23, 29, 32, 24, 25, 30, 33, 34, 35.)

To all the pots, except 28, 29, 30, 31, 32, 33, 34, 35, a definite quantity of water extract of garden soil as described on page 79 was added to ensure a supply of the microbes found in cultivated ground and so possibly to promote decay and nitrification.

To determine whether this addition was advantageous the following comparisons were made.

Pots 22, 23, 24, 25 received the soil extract just referred to.

Pots 28, 29, 30, received no soil extract.

To each of the pots 31, 32, 33, 34 and 35 were added 100 grams of rich garden soil.

Pots 34 and 35 received no additional nitrogen but to all the others nitrogen was supplied in the form of Dried Blood.

Table IV.—Effects of Adding Garden Soil or Soil Extract to the Artificial Soil.

The arrangement of the series and the results obtained are given below.

Pot.	Quantity of Blood Nitrogen.	Addition.	Crop Increase. grams.	Crop increase. Per ct.	Nitrogen in Crop increase. grams.	Nitrogen in Crop increase. Per ct.
22	.8 gram.	Soil Extract.	73 4	100*	.317	100*
28	.8 "	Nothing.	76.6	104	.289	91
31	.8 "	100 grams garden soil.	70 2	95	.337	106
23	1.6 "	Soil Extract.	126.3	100*	.587	100*
29	1.6 "	Nothing.	123.7	98	.646	110
32	1.6 "	100 grams garden soil.	114.7	90	.529	90
24	2.4 "	Soil Extract.	132.3	100*	.914	100*
25	2.4 "	" "	138.1		1.013	
30	2.4 "	Nothing.	135.4	100	.976	101
33	2.4 "	100 grams garden soil.	143.8	106	1.026	106
34	none	" "	2.5		.006	
35	none	" "	.3		none	

* Taken as 100 because used in most of the experiments.

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With a nitrogen supply of .8 gram the pot without soil or soil extract gave the largest crop increase and that with addition of garden soil, the smallest. The extremes were nine per cent. apart.

The pot with added garden soil showed the largest nitrogen increase, that with nothing added, least. Extreme difference 15 per cent.

When 1.6 grams of nitrogen were supplied the pot that received soil extract had the largest crop increase, the one with added garden soil the smallest. The extremes were ten per cent. apart.

The pot with no soil extract had the largest nitrogen increase, that with added garden soil, the least. Extreme difference 20 per cent.

When 2.4 grams of nitrogen were employed two pots were treated with soil extract.

The crops in these two pots differed in amount by 5 per cent. The amount of the nitrogen differed by 11 per cent.

The results of the three series of experiments are contradictory and the differences are probably within the limits of experimental error. They cannot therefore be regarded as significant.

The crop increase produced by 100 grams of garden soil above is shown to be trifling.

The experiments have not established that the nitrogen of dried blood was made any more available by the admixture of soil extract or of garden earth with the artificial soil.

The results have no bearing on the question whether nitrification is a necessary preliminary to the assimilation of organic nitrogen by the plant.

They only indicate that no artificial inoculation with soil-microbes was necessary to insure assimilation of nitrogen in the culture-trials here described.

ARE THE QUANTITIES OF OTHER PLANT FOOD, ESPECIALLY PHOSPHORIC ACID AND POTASH IN EXCESS OF THE REQUIREMENTS OF THE PLANTS?

(Pots Nos. 22, 45, 46, 47, 48, 49, 36, 37, 23, 38, 39, 40, 41, 23, 42, 43, 44.)

If so, then the crop, so far as the supply of plant food is concerned, is limited only by the quantity of nitrogen which is available.

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If however the ingredients named are not in excess, the crop is limited in part by lack of them and the weight of crop is no longer a measure of the availability of the nitrogen.

On this point we have two series of experiments; in the first of which .8 gram of nitrogen in dried blood were used, and in the second 1.6 grams.

By "normal" quantity of potash (K_2O) is meant 2.04 grams the amount used in all the experiments of 1894 with the exceptions presently to be noted.

The "normal" quantity of phosphoric acid (P_2O_5) (also used in all the experiments of 1894 with the exceptions noted here) was 1.18 grams.*

The results of the first series, in which .8 gram nitrogen were used are as follows:

TABLE V.—EFFECTS OF DIFFERENT QUANTITIES OF PHOSPHORIC ACID AND POTASH, ON CROP PRODUCTION.

				Crop increase.		Nitrogen.	
				grams.	p. c.	gram.	p. c.
Pot 22,	Normal phosphoric acid,		Normal potash,	73.4	100	.317	100
45,	"	"	1¼ "	79.5	109	.304	96
46,	"	"	1½ "	87.4	119	.300	94
47, 1¼	Normal phosphoric acid,		Normal potash,	72.6	99	.331	104
48, 1.7	"	"	"	81.9	111	.308	97
49, 1.7	"	"	1½ "	86.7	118	.316	99

A study of these results shows that when potash was present in one fourth more than "normal" quantity as in pot 45, there was a crop-increase of 9 per cent. Potash in one-half more than normal quantity, (pot 46) made a further crop-increase of 10 per cent. The first crop-increase is perhaps within the limits of error but the second, taken with the first, indicates that with more potash the crops would have been larger.

Phosphoric acid was plainly in excess. The observed gain in pot 48 is nearly within the limits of error and the gain in pot 49 is accounted for fully by the extra potash present.

The nitrogen-increase, however, was not affected by either potash or phosphoric acid in excess of the normal quantities.

It appears that potash was not in relative excess when used in "normal" quantity *judging from the total crop increase*, but that with 0.8 gram of nitrogen in the fertilizer the total nitrogen of the crop is a fair measure of the availability of the nitrogen of the fertilizer.

* See page 78.

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The results of the second series, with 1.6 grams of nitrogen are as follows :

TABLE VI.—EFFECTS OF DIFFERENT QUANTITIES OF PHOSPHORIC ACID AND POTASH ON CROP PRODUCTION.

							Crop increase.		Nitrogen.	
							grams.	per cent.	gram.	per cent.
Pot 23	normal	phos.	acid,		normal	potash,	126.3	100	.587	100
36	"	"	"	½	"	"	117.3	93	.509	87
37	"	"	"	¾	"	"	115.5	91	.511	87
38	"	"	"	1½	"	"	109.7	87	.551	94
39	"	"	"	1¾	"	"	124.5	98	.544	92
40	½ normal	phos.	acid,		normal	potash,	107.0	85	.498	85
41	¾ "	"	"		"	"	125.8	99	.542	92
42	1½ "	"	"		"	"	122.8	97	.565	96
43	1.7 "	"	"		"	"	129.4	102	.630	107
44	1.7 "	"	"	1½	"	"	118.8	94	.536	91

In these tests neither less potash than the normal quantity, nor more than the normal, produced any striking difference in the quantity of crop. The cause of the smaller crop in pot 38 as compared with the crops in 37 and 39 does not appear.

Less potash than the normal quantity, was attended with less assimilation of nitrogen while increase of potash above normal did not increase the nitrogen of the crop.

One half the normal quantity of phosphoric acid in the fertilizer gave less crop-increase and less nitrogen-increase than normal while increase of the phosphoric acid of the fertilizer above normal made no appreciable change either in quantity of crop or crop-nitrogen. When *both* potash and phosphoric acid of the fertilizer were increased above normal (pot 44), no increase of crop or crop-nitrogen followed.

The "normal" potash supply was shown to be too small for maximum crop production in the cases where .8 gram of nitrogen were used, but where 1.6 grams of nitrogen were present the normal amount of potash does not appear deficient. It is hardly conceivable that potash should be relatively deficient with the less quantity of nitrogen, but not deficient with a larger quantity, unless the effect of the larger quantity of nitrogen is limited by some other factor.

Now it has been already shown on page 89 in studying the relations of water to crop production that when 1.6 grams of nitrogen in form of blood were used with the quantity of water

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which was supplied to the pots now under discussion, the crop production, *but not the crop-nitrogen*, was limited by the water.

The water was not in excess of the crop requirements.

This furnishes the explanation of the results here given.

When .8 gram nitrogen was supplied, the water supply was in excess of the crop requirements and the "normal" potash ration was slightly deficient for maximum crop production.

When 1.6 grams nitrogen were supplied, the water supply was slightly deficient, the nitrogen consequently did not come to its full working in crop production and therefore the "normal" potash ration was not the factor which limited production.

The experiments above described are preliminary to those which form the main subject of this paper.

Their object is to determine whether the supply of plant food and of water has been so chosen that both are in relative excess and how far the differences in weight of crops observed in the experiments to be described later may justly be attributed to the quality and quantity of the nitrogen supply.

These results may be summarized as follows:

1. The inoculation of the artificial soil with either soil extract or garden soil was without effect and therefore unnecessary.

2. FOR THE ASSIMILATION OF NITROGEN the "normal" water supply was sufficient or in excess when .8 gram or 1.6 grams nitrogen were used in the fertilizer. There are no data to demonstrate whether with 2.4 or 3.2 grams of nitrogen, the water supply was deficient.

3. FOR MAXIMUM CROP PRODUCTION, the water supply was probably scarcely sufficient when .8 gram. nitrogen were used and was no doubt somewhat deficient when 1.6 grams nitrogen were employed.

4. FOR THE ASSIMILATION OF NITROGEN the "normal" quantity of potash was certainly in excess of the plant requirements when .8 gram nitrogen were used in the fertilizer and was probably also in excess when 1.6 grams nitrogen were present.

5. FOR MAXIMUM CROP PRODUCTION potash was deficient in all cases.

6. In the following experiments no conclusions as to the availability of nitrogen are safe where more than 1.6 grams of nitrogen were used in the fertilizer.

7. The quantity of nitrogen taken up by the crop is a fairer measure of its availability than the total weight of the crop.

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The Relative Availability of Nitrogen in certain Raw Materials commonly used in Fertilizers.

(Pots 5, 6, 7, 8, 9, 10, 11, 12, 13, 22, 23, 24, 25, 26, 27, 102 to 117 (both inclusive) and 123 to 130 (both inclusive).

The nitrogenous matters used in these experiments were the following:

Commercial nitrate of soda, slightly dried to facilitate grinding and weighing and containing 16.15 per cent. of nitrogen.

Dried Blood, bought from a dealer in fertilizers, which contained 13.2 per cent. nitrogen.

Castor Pomace, A, a ground residue left after the removal of oil from the castor bean (*Ricinus*). The sample contained 5.4 per cent. of nitrogen.

Castor Pomace, B, another sample, containing 5.56 per cent. of nitrogen.

Cotton Seed Meal. Bright yellow meal from the Conn. market, containing 7.38 per cent. of nitrogen.

Dry Ground Fish, containing 9.34 per cent. of nitrogen.

Ground Horn and Hoof from Chicago. See description on page 20, containing 15.59 per cent. of nitrogen.

Tankage, bought in New Haven, which contained 4.17 per cent. of nitrogen.

Linseed Meal, used extensively in this State as a cattle food but also, among tobacco growers, as a fertilizer. It contained 5.75 per cent. of nitrogen.

All of the above materials were pulverized to pass circular holes $\frac{1}{50}$ inch in diameter.

For the most part four pots were devoted to tests of each material and each was used in such quantity as supplied .8, 1.6, 2.4 and 3.2 grams of nitrogen to the four pots respectively.

The quantities of other plant food supplied are given on page 78.

Nitrate of soda is taken as the standard of comparison.

The following table shows the amount of crop increase (over the crop in pots which received no nitrogen) obtained by the use of .8 gram of nitrogen in the nitrogenous matters named and also the amount of nitrogen increase; both being expressed in grams.

The last two columns give the relative crop and nitrogen increase, as compared with the increase obtained from nitrate of soda which is called 100 per cent.

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TABLE VII.—COMPARATIVE AVAILABILITY OF NITROGEN IN VARIOUS FERTILIZERS.

CROP INCREASE WITH .8 GRAM NITROGEN.

Pot.	Source of Nitrogen.	Crop Increase. grams.	Nitrogen Increase. gram.	Relative Crop Increase when Nitrate = 100 p. c. Crop. per cent.	Nitrogen. per cent.
9	Nitrate of Soda	96.7	.367	100	100
22	Dried Blood	73.4	.317	75.9	86.4
102	Castor Pomace A	83.8	.298	86.7	81.2
106	Castor Pomace B	80.3	.334	83.0	91.0
110	Cotton Seed Meal	71.7	.313	74.1	85.3
114	Dry Fish	70.1	.280	72.5	76.3
5	Horn and Hoof	70.9	.290	73.3	79.0
123	Tankage	62.2	.265	64.3	72.2
127	Linseed Meal	78.2	.313	80.8	85.3

In Table VIII are given the corresponding experiments made with the double quantity of nitrogen, 1.6 grams.

TABLE VIII.—COMPARATIVE AVAILABILITY OF NITROGEN IN VARIOUS FERTILIZERS.

CROP INCREASE WITH 1.6 GRAMS NITROGEN.

Pot.	Source of Nitrogen.	Crop Increase.	Nitrogen Increase.	Relative Crop Increase when Nitrate = 100 p. c. Crop.	Nitrogen.
10	Nitrate	137.7	.850	100	100
23	Dried Blood	126.3	.587	91.8	69.1
103	Castor Pomace A	94.7	.488	68.7	57.5
107	Castor Pomace B	136.9	.663	99.4	78.0
111	Cotton Seed Meal	113.2	.572	82.2	67.3
115	Dry Fish	111.6	.514	81.0	60.5
6	Horn and Hoof	115.8	.544	84.0	63.9
124	Tankage	122.0	.573	88.6	67.4
128	Linseed Meal	113.1	.618	82.1	72.7

We may now inquire what conclusions are justified regarding the availability of nitrogen in the various forms here under experiment.

The most accurate data are probably those of Table VII with the smaller quantity of nitrogen.

Regarding the *total crop increase* produced, it appears that the two kinds of Castor Pomace gave 86.7 and 83 per cent. of the crop which nitrate of soda gave, and larger crops than any of the other fertilizers.

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Linseed Meal ranked next, and but little below the Castor Pomace, 80.8 per cent.

Then followed Dried Blood 75.9, Cotton Seed Meal 74.1, Horn and Hoof 73.3, Dry Fish 72.5 per cent.

Tankage is at the foot of the list, producing only 64.3 per cent. of the crop produced by nitrate of soda used in equivalent quantity.

Regarding in the next place the *nitrogen increase* it appears that next to nitrate came Castor Pomace B, 91.0 per cent.

Next, and nearly alike, were Dried Blood (86.4), Cotton Seed Meal (85.3) and Linseed Meal (85.3).

Somewhat below these ranked Castor Pomace A, 81.2 per cent., and Horn and Hoof, 79.0 per cent.

Then followed Dry Fish, 76.3 per cent. and last of all Tankage of whose nitrogen only 72.2 per cent. had been assimilated as compared with that yielded by nitrate of soda.

As appears from the conclusions on page 93 the only other data, which can fairly be used in discussing the relative value of nitrogen in these materials are the yields of nitrogen from those crops raised with the double quantity of this element.

An examination of these figures given in Table VIII, page 95, shows that Castor Pomace B, ranked next to Nitrate of Soda in respect of the assimilation of its nitrogen by the crop, 78 per cent.

Considerably below this was the availability of nitrogen in Linseed Meal 72.7, and Dried Blood 69.1.

A little lower ranked Tankage 67.4, and Cotton Seed Meal 67.3. Next lower was Horn and Hoof 63. 9, Fish 60.5, and last of all the Castor Pomace A 57.5.

The indications of these three sets of figures are sufficiently alike to warrant averaging the per cents. found, to obtain a general numerical expression of the result of the tests.

Such an average shows that under the conditions of this experiment, of the organic forms of Nitrogen, Castor Pomace B was the most available, 85 per cent., when nitrate of soda equals 100 per cent. Somewhat less available was the nitrogen of Linseed Meal, 80.0 and of Blood 77 per cent.

Next came Cotton Seed Meal, 76, Castor Pomace A, 74, and Horn and Hoof, 72 per cent.

Last came Dry Fish, 70, and Tankage, 68.0 per cent.

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Extended discussion of these results is reserved till the tests have been repeated under varying conditions.

There are two or three particulars however to which attention may be called at the present time.

It is noteworthy that the nitrogen of one sample of Castor Pomace was very much more available than that of the other.

The reason of this difference it has not yet been possible to discover.

The nitrogen of Dry Fish and Tankage had a lower availability in these experiments than that of blood and the vegetable nitrogenous matters, rather lower indeed than horn and hoof. This is quite contrary to the popular estimate of the relative value of dried fish. It is generally regarded as one of the most active forms of nitrogen. Perhaps the same is true of tankage. This sample of tankage contained 4.17 per cent. of nitrogen and was therefore a "bone tankage" differing little in composition from ground bone and had undoubtedly been subjected to cooking and drying at a temperature of about 212° Fahr.

It will be noticed in Table IX, given on page 100, that Wagner finds from three years' experiments that the nitrogen of both blood and castor pomace is more fully available than that of either fish guano, steamed bone meal or "flesh meal;"—results which in general are confirmed by these trials.

These facts remind us of the insolubility or slowness of solution of dry ground fish and tankage in pepsin solution as contrasted with dried blood and raw bone; Report for 1893, pp. 220 and 222. Also Report for 1885, pp. 124–127. (Note the higher solubility of fresh-cooked menhaden, Fish No. 1598, Report 1885, page 123 and conclusion on page 126.)

It appears that some animal matters which yield gelatine (glue), viz: those of bone, of tendon, cartilage, hide, and the various intestinal membranes, are rendered less soluble and digestible by cooking or steaming; while others, constituting wool, hair, horn and hoof are made more soluble or digestible by cooking or steaming. In case of the former, the glue produced by the action of hot water or steam, makes a solution which impregnates the undissolved matter, and when the whole is dried fills the pores and covers and cements together the particles with a material which is quite insoluble in water of ordinary temperature so that the porosity of the whole mass is greatly diminished. In consequence of this, the material when steamed and dried dis-

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solves less readily, decays much more slowly,—is less "available" to plants—than it was in its fresh or raw condition.

These remarks, of course, do not apply to processes which remove the glue quite completely from the material before drying. On the other hand, in case of wool, hair, horn and hoof, heating or steaming at the temperature usually employed produces no glue which may afterwards lessen porosity, but destroys the toughness and elasticity of these materials. Before steaming they are pulverized with the greatest difficulty; after steaming they are brittle and readily reduced to a fine powder. Thus the same process which makes fish and tankage less easy to pulverize, slower to dissolve, digest and decay, and less available to plants, makes horn and hoof, hair and wool, more easily pulverizable, quicker to decay and more available as plant food.

In the Report of this Station for 1886, page 88, is described a vegetation experiment on the agricultural value of horn shavings and horn and hoof. In this test, oats were grown in pots filled with a natural soil.

The outcome of that experiment is stated as follows: "The results are too irregular to justify any fine conclusions, but the average increase both of dry matter and of nitrogen is seen to be twice as much in the case of blood-nitrogen as in that of horn-nitrogen." . . . . "In these experiments both horn and hoof and horn shavings proved to be of very inferior value as fertilizers in comparison with dried blood."

In the experiments of this year, on the contrary, the nitrogen of ground horn and hoof was nearly as effective as that of dried blood.

In the experiments of 1886 the availability of blood-nitrogen was to that of horn-nitrogen as 100 to 46½. In the experiments of 1894 the relation was 100 to 93. There are two considerations which may fully explain this seeming discrepancy.

In 1886 the crop raised was oats; the time of growth was from May 3d to July 28th, a period of 79 days; and the temperature during the time of growth was comparatively low.

In 1894 the crop raised was maize; the time of growth was from June 16th to Aug. 28th, a period of 73 days; and the temperature during growth was exceptionally high.

While the time of growth was about the same for the two crops that time in the case of corn fell in the very warmest part of summer, while the oats grew in much cooler weather, and pre-

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sumably the putrefactive and nitrifying processes within the soil were very much less active than six weeks later, at the time when the maize crop was most rapidly growing.

The other fact which explains the differences noted between the the availability of the nitrogen of horn and hoof in 1886 and in 1894 is that the character of the material used in the two series of experiments was quite different.

The horn and hoof samples used in the tests of 1886 were turnings from factories, raw or unsteamed and extremely hard to pulverize.

The firm who furnished the horn and hoof used in the tests of 1893 stated that it had been steamed. It was, at all events, a brittle material, totally different in texture from the other and very easily ground to a fine powder.

While the horn and hoof was ground to pass a $\frac{1}{10}$ inch mesh for both series of experiments it is quite certain that the preparation used in 1893 was on the whole much finer than the other and probably for this reason was more quickly decomposed and rendered available to plants.

Before leaving this subject we may cite the results of vegetation experiments made by Wagner* on the relative availability of nitrogen in various fertilizer materials.

The crops under experiment were summer rye, with flax following, summer wheat, and carrots. The tests were made on small plots of ground.

Expressing the nitrogen increase obtained by use of nitrate of soda as 100, the relative increase from the other materials was as follows:

* Die Stickstoffdüngung der Landwirtschaftl. Kulturpflanzen, 246.

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TABLE IX.—RESULTS OF WAGNER'S EXPERIMENTS. THE RELATIVE AVAILABILITY OF VARIOUS FORMS OF ORGANIC NITROGENOUS MATTER.

	In experiment of the first year.	Average of first and second year's experiment.	Average of first, second and third year's experiment.
Nitrate of Soda	100	100	100
Sulphate of Ammonia	85	74	88
Peruvian Guano	84	88	80
Blood Meal	67	67	69
Castor Pomace	62	65	67
Green Crop Manure	62	60	68
Horn Meal	63	61	63
Fish Guano	51	59	64
Steamed Bone Meal	42	53	61
Flesh Meal	44	47	54
Wool Dust	27	28	33
Stable Manure	11	16	32
Leather Meal	13	12	20

The experiments made in *pots* with oats, carrots and summer rye gave results not essentially different from these.

Wagner says in discussing the figures above given: "Of course these statements of value can only represent approximately the availability of these nitrogenous matters in comparison with nitrate of soda. It would be foolish to attempt a numerical expression which should be absolutely correct in all cases.

Under conditions more favorable to the decay and nitrification of organic matters, than prevailed in our tests,—if the soil is richer in humus or lime, lighter, warmer, etc., or if a crop is grown, which has a longer period of growth and with it a greater capacity for assimilating nitrogen—then the above figures will be somewhat higher, and on the other hand (under less favorable conditions), lower."

THE RELATIVE AVAILABILITY OF NITROGEN IN VARIOUS PREPARATIONS OF LEATHER.

A considerable number of methods have been tried in this country and abroad to destroy the tannic acid and render the nitrogen of leather available to plants.

A bibliography of this subject up to date, prepared by Dr. J. B. Lindsey of the Massachusetts Station, may be found in Agricultural Science, Vol. VII, No. 2, p. 50.

As various preparations of leather are to be had in our markets at comparatively low rates, the following experiments were made

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to test the effect of roasting, steaming and acidulating leather on the availability of its nitrogen.

The preparations used were as follows:—

1. Leather and garbage. This material, which is fine and easily pulverized, contains a considerable proportion of leather, but we have no precise information regarding its source or method of manufacture. It was purchased for us from a broker. The sample contained 7.26 per cent. of nitrogen.

2. Raw leather (hemlock-tanned, sole leather chips) ground to a fine powder, which contained 6.61 per cent. of nitrogen.

3. Roasted leather, made from the same raw leather by powdering and heating in an air bath at 240° C. for four hours. It contained 10.24 per cent. of nitrogen.

4. Steamed leather, prepared from the same raw leather, by heating over water in the autoclave for 1¾ hours at a pressure of 58 pounds to the square inch. It formed a gummy mass which after drying at 100° C. in a water bath became friable, and contained 7.11 per cent. of nitrogen.

5. Dissolved leather, obtained as follows: To 36 parts of hot oil of vitriol, free from nitrogen, were gradually added, with constant stirring, 32 parts of pulverized raw leather, like No. 2 above mentioned. This was more than the acid would at once blacken. The mass was rubbed thoroughly together and heated till fumes of sulphurous acid began to appear. The acid was then nearly neutralized with carbonate of lime and the mixture was dried on the water bath till it became friable. It contained 2.07 per cent. of nitrogen and gave no reaction for tannic acid when tested in the usual way with iron-salt.

TABLE X.—COMPARATIVE AVAILABILITY OF NITROGEN IN VARIOUS PREPARATIONS OF LEATHER.

Pot No.		Quantity of Nitrogen in Fertilizer.	Crop Increase.	Nitrogen Increase.	Relative Crop Increase when Nitrate = 100 per cent.	Relative Nitrogen Increase when Nitrate = 100 per cent.
9	Nitrate of Soda.....	.8	96.72	.367	100	100
10	" "	1.6	137.71	.850	100	100
138	Leather and Garbage.	.8	22 51	.122	23.3	33.2
139	" " " .	1.6	62.10	.240	45.1	28.3
135	Raw Leather	.8	none	none	none	none
136	" "	1.6	none	none	none	none
142	Steamed Leather....	.8	6.32	.030	6.5	8.1
143	" "	1.6	9.73	.036	7.0	4.2
146	Roasted Leather.....	.8	4.24	.023	4.4	6.3
147	" "	1.6	12.03	.054	8.8	6.3
137	Dissolved Leather...	.8	70.10	.291	72.5	79.3

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It appears that raw leather finely pulverized was absolutely inert under the conditions of this experiment, that steamed and roasted leather were so slowly available as to be nearly worthless but that the nitrogen of leather which had been heated with more than its own weight of oil of vitriol was as available as that of dry fish or horn and hoof. This last result, of a single test, needs confirmation.

The nitrogen in the mixture of leather and garbage was less than half as available as that of fish, or horn and hoof.

The Availability of the "Organic" Nitrogen of Mixed Fertilizers.

Under the general name of "animal matter" a considerable number of inferior or perhaps nearly worthless nitrogenous manufacturing wastes are now offered to makers of commercial fertilizers. Very often nothing can be learned regarding their nature, or fertilizing value. Some of them moreover can be mixed with dried blood or with tankage in considerable quantity without betraying their presence on casual examination.

It is an important question whether any considerable amount of this suspicious material enters into our market in mixed goods.

In 1893 this Station tested every mixed fertilizer that came into the laboratory, by determining how soluble its organic nitrogenous matter was in water and pepsin-hydrochloric acid.* The result of this study was follows :

"Of the 125 brands of mixed fertilizers examined, this method accordingly finds that 105 were above suspicion, 12 were near the danger line, and 8 were to be suspected of containing some comparatively worthless form of organic nitrogen. The method cannot at present do more than create a strong presumption for or against the quality of the goods."

It was decided this year to test if possible the value of the organic nitrogen of certain mixed fertilizers by practical pot cultures.

For this purpose it was needful to separate the organic nitrogen from accompanying nitrates and ammonia salts as well as from fully soluble phosphates, potash, etc.

This was accomplished by washing with water as follows: 250 grams of each fertilizer were shaken in a fruit jar with 300^{cc} of cold water and after standing some time 200^{cc} of the liquid were poured off through a paper filter, 200^{cc} of water were added to

* Rept. Conn. Exp't. Station, 1893, 223.

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the residue in the jar, shaken, let stand until nearly clear and poured off as before. This process was repeated six times.

The residue was then brought on the filter and washed sufficiently to collect all the solid particles. The residue was then dried, separated from the filter, weighed, ground and sifted to pass circular holes $\frac{1}{25}$ inch in diameter.

Nitrogen was determined in this washed residue as well as in the original material.

It is therefore possible to compute the quantity of organic nitrogen which was undissolved by water during the washing process.

Of the thirty-nine mixed fertilizers tested, the proportion of organic nitrogen undissolved by washing with cold water was

In 1 case	more than			95	per cent.
" 7 cases	between	85	and 90	"	
" 5 "	"	80	" 85	"	
" 6 "	"	75	" 80	"	
" 4 "	"	70	" 75	"	
" 7 "	"	65	" 70	"	
" 5 "	"	60	" 65	"	
" 3 "	"	60	" 40	"	
" 1 "	less than		40	"	

It appears then that in washing, a considerable portion of the organic nitrogen has in most cases been dissolved.

The vegetation tests are therefore made only *on that portion of the organic nitrogen which was undissolved by cold water.*

Certain preliminary experiments had indicated that the solubility of the organic nitrogen was not nearly so great as it proved to be in many cases. The results are accordingly less valuable than was expected.

The general result of the vegetation test made with twenty-seven mixed fertilizers is as follows:

In fifteen of the fertilizers, the part of the organic nitrogen which was undissolved by cold water appeared to be rather less available than that of dried blood.

If the availability of nitrogen in nitrate of soda is called 100, and of that of Blood 77, then the availability of the nitrogen of these fifteen fertilizers is between 60 and 70.

In one other case							the relative nitrogen availability was		78	.0
" two others							" between	55	and	60
" four	"	"	"	"	"	"	"	50	"	55
" two	"	"	"	"	"	"	"	45	"	50
" two	"	"	"	"	"	"	"	40	"	45
" one	"	"	"	"	"	"	"	35	"	40

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While it is true that this statement refers only to a portion of the organic nitrogen,—the part which was undissolved by cold water,—it is nevertheless evident that there are very decided differences in the availability to plants as well as in the solubility in water of the organic nitrogen of mixed fertilizers. These differences we believe can only be demonstrated by vegetation experiments made in general like those here described.

Field tests, as usually conducted are quite unfit for this purpose, however useful they may be in other ways.

In future experiments it is hoped that the entire organic nitrogen of mixed fertilizers may be practically tested in pot culture. Further discussion of the results of the present year is therefore reserved.

In concluding the account of our vegetation experiments it may be well to supplement the description, by a few illustrations.

The accompanying plates, III, IV, V and VI, show the appearance of five cultures at four different periods of growth.

Pot 9 received at planting time, June 17, .8 gram (12 grains) of nitrogen in form of nitrate of soda while the other pots 1, 2, 3 and 4 had no nitrogen except what came from the seed, and the very small quantity which the artificial soil supplied. In all other respects the soil of the five pots was fertilized in the same manner.

The first picture, Plate III, was taken July 20th.

No. 9 had reached a height of about 57 inches, the foliage was dark green and the whole appearance very thrifty. Nos. 1, 2, 3 and 4 were about 14 inches high, the leaves were yellowish or reddish, growth was at a standstill, and as new leaves developed, the old ones withered.

On August 6th, there was added to the soil of No. 1, .8 gram of nitrogen in form of nitrate of soda.

Within four days the color of the foliage improved and on August 16th, the second picture was taken, Plate IV. It is quite evident here that new growth has begun, and that the plant which showed most strength appropriates the nitrogen supply most promptly and effectively under the changed conditions. The other three plants have made no appreciable growth.

The next two pictures Plates V and VI show the appearance of this series on Aug. 28 and Sept. 18. In the meantime the crop of pot 3 had been harvested.

The plants in pot 1 made good growth, though of course greatly

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PLATE III. Effects of Nitrate of Soda.

PLATE IV. Effects of Nitrate of Soda.

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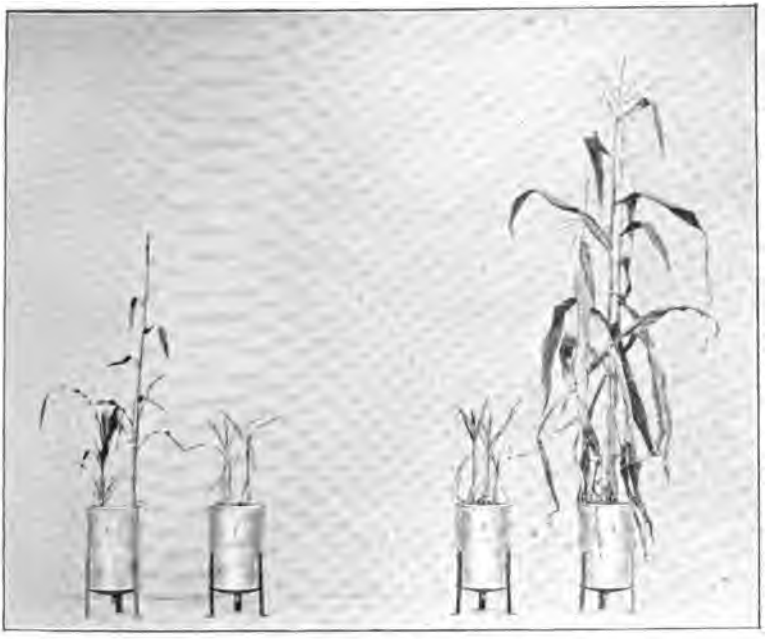

PLATE V. Effects of Nitrate of Soda.

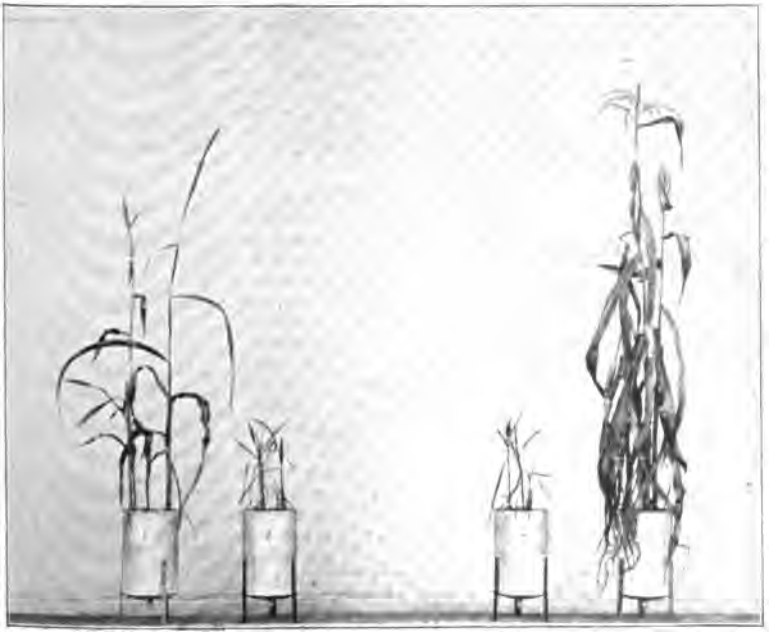

PLATE VI. Effects of Nitrate of Soda.

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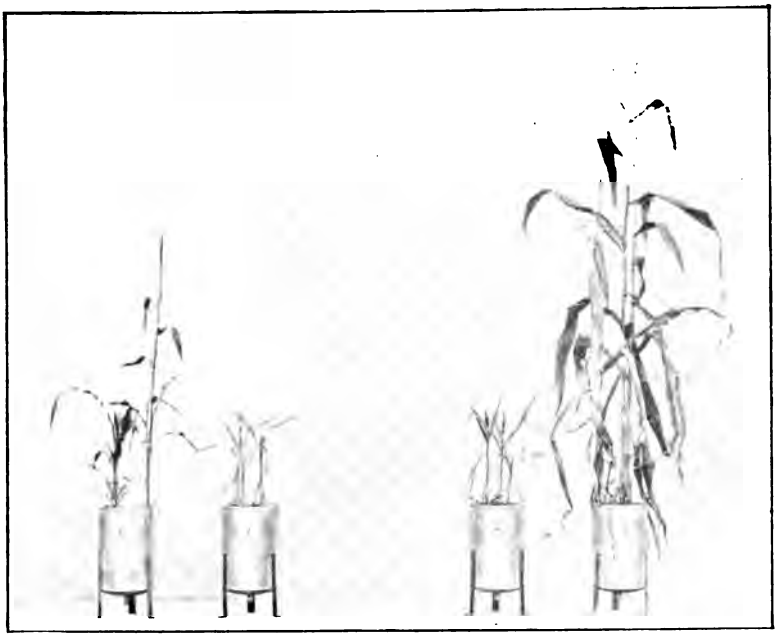

PLATE V. Effects of Nitrate of Soda.

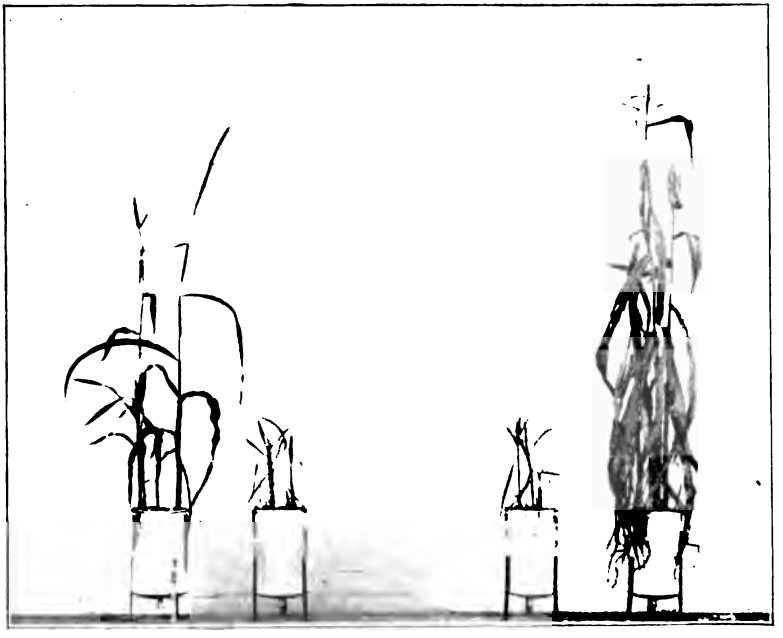

PLATE VI. Effects of Nitrate of Soda.

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No Nitrogen. | Raw Leather. | Leather and Garbage. | Steamed Leather. | Roasted Leather. | Dissolved Leather.

PLATE VII.

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inferior to those in pot 9, and two of them developed diminutive ears.

The plants in 2 and 4 stood without any real growth through the whole season.

Plate VII shows the relative value of the different preparations of leather described on page 101. Beginning at the left of the picture, pot No. 2, received no nitrogen, pot 136, received 1.6 grams of nitrogen in form of pulverized raw leather, pot 139 received the same quantity of nitrogen in "leather and garbage," pot 144 received steamed leather, pot 147, roasted leather and pot 137 received only half as much nitrogen as the others, but in form of "dissolved leather."

The picture as well as the analytical results indicate that raw leather was rather worse than useless as a source of nitrogen, that the nitrogen of roasted and steamed leather was of very little value as as a fertilizer, "leather and garbage" did better than these last, thanks to the garbage ingredients, but dissolved leather did much better than any thing else in the series.

II. RELATIVE SOLUBILITY OF ORGANIC NITROGENOUS MATTERS IN PEPSIN-HYDROCHLORIC ACID.

Raw Materials used in Fertilizers.

For the results of work done in past years on this subject reference may be had to the Seventeenth Report of this Station, 1893, pp. 218–223.

This year the thirteen materials tested by vegetation experiments as described on pages 94 to 96 of the present Report have also been examined as to their solubility in pepsin-hydrochloric acid, in order to ascertain if there was any relation between the relative availability and the relative solubility (in pepsin-solution) of their nitrogen.

The method followed is precisely that described on page 219 of the Seventeenth Report.

The results are given below in Table XI.

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TABLE XI.—SOLUBILITY IN PEPSIN-HYDROCHLORIC ACID OF ORGANIC NITROGEN IN VARIOUS RAW MATERIALS.

	Total Nitrogen in per cent. of the substance.	Pepsin-soluble Nitrogen in per cent. of the substance.	Pepsin-soluble Nitrogen in per cent. of total Nitrogen.
Dried Blood	13.20	12.31	93.3
Castor Pomace A	5 40	4.64	86.0
Castor Pomace B	5.56	4.94	88.9
Cotton Seed Meal	7.38	6.59	89.3
Dry Fish	9.34	7.46	81.0
Horn and Hoof	15.59	5.46	35.0
Tankage	4.17	2.84	68.1
Linseed Meal	5.75	5.27	91.6
Leather and Garbage	7.36	2.98	41.0
Raw Leather	6.61	.57	8.6
Steamed Leather	7.11	1.44	20.3
Roasted Leather	10.24	.87	8.5
Dissolved Leather	2.07	.11	5.3

What connection there is between the solubility of these materials in pepsin-solution and the availability of their nitrogen as determined by vegetation experiments may be seen in Table XII.

The second column of this table contains the figures which express the average relative availability of the nitrogen as determined by the vegetation experiments which have been described on pages 94 to 96 and page 101 of this report.

The third column is calculated from the last column of Table XI by multiplying the figures expressing the relative solubility of the nitrogen in pepsin-solution by the factor .826. By this means the figure in the third column (77.1) representing the solubility of the nitrogen of dried blood in pepsin-solution is made the same as that in the second column representing the availability of the nitrogen of dried blood, as determined by vegetation experiments. Hence if there were absolute agreement between the relative availability of the nitrogen and its relative solubility in pepsin-solution, the figures in the third column should be the same as the corresponding ones in the second column.

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TABLE XII.—COMPARISON OF NITROGEN AVAILABILITY BY MAIZE AND SOLUBILITY IN PEPSIN-SOLUTION.—RAW MATERIALS.

	Relative Availability.	Relative Solubility in Pepsin-Solution.
Dried Blood	77.1	77.1
Castor Pomace B.	85.2	76.5
Linseed Meal	79.6	75.6
Cotton Seed Meal	75.5	73.8
Castor Pomace A.	73.9	71.0
Horn and Hoof	72.1	28.9
Dry Fish	69.8	66.9
Tankage	67.9	56.2
Leather and Garbage	30.8	33.8
Raw Leather	0.0	7.1
Steamed Leather	6.2	16.8
Roasted Leather	6.3	7.0
Dissolved Leather	79.3	5.3

With three exceptions, the agreement between these two columns of figures is satisfactory.

In general, therefore, the solubility of the nitrogen of these samples in pepsin solution was a fairly good measure of the relative availability of the nitrogen to the corn plant under the conditions of our vegetation experiment.

The difference between the results obtained with castor pomace B. (8.7) is hardly significant. The difference in case of tankage (11.7) is more pronounced.

In the case of horn and hoof the relative availability of the nitrogen is not indicated in the least by its solubility in pepsin solution. The former is represented by the figure 72.1, the latter by 28.9.

The same is true of the dissolved leather, where the availability of the nitrogen is represented by 79.3, the solubility in pepsin by 4.3.

In the case of horn and hoof we believe the discrepancy is one which cannot possibly be attributed to errors of experiment. Our tests previously made are confirmed by the results of this year and prove that pepsin-solution will not under the conditions of the test dissolve more than about 30 per cent. of the nitrogen of horn and hoof.

The results of the four vegetation tests made this year were consistent and showed that the nitrogen of horn and hoof was as available as that of castor pomace, dry fish and tankage.

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Wagner's vegetation experiments carried on for three years on small plots of soil and with other crops than maize also showed that the nitrogen of horn and hoof was as available as that of fish guano or bone meal.

But the nitrogen of castor pomace, dry fish, tankage and bone, which in these experiments proved to be no more available to crops than that of horn and hoof, dissolves in pepsin-solution far more readily. Solubility in pepsin-solution is no indication, therefore, of the availability of the nitrogen of horn and hoof.

The sample of dissolved leather contained a very large amount of sulphate of lime produced when the oil of vitriol was neutralized by carbonate of lime, as described on page 101.

Previously to digestion with pepsin-solution the gram portion of dissolved leather was digested for an hour with 250^{cc} of .2 per cent. hydrochloric acid and then washed copiously with cold water. While our experiments have shown (Report, 1885, p. 121), that a very large amount of gypsum interferes considerably with the solvent action of pepsin-hydrochloric acid, it was believed that this preliminary treatment would nearly, if not entirely, remove the excess of gypsum. The tests prove, however, that the nitrogen is almost entirely insoluble in pepsin-solution.

We have, on the other hand, but a single vegetation experiment with this sample, and the result obtained requires confirmation by further experiment.

The Organic Nitrogen of Mixed Fertilizers.

The method of removing ammonia salts and nitrates from mixed fertilizers has been described on page 102.

The vegetation tests, as described on page 103, were made with that portion of the organic nitrogen which was insoluble in cold water.

The following determinations of solubility in pepsin-solution were *also* made on the portion of organic nitrogen insoluble in water, using the same preparations which had been made for the vegetation experiments.

Six fertilizers were selected, Nos. II, V, XI, XII, XVI, and XVIII (pots 51, 52, 57, 58, 68, 69, 70, 71, 78, 81, 82), being those which had shown the lowest nitrogen availability. The method of digestion with pepsin-solution was the same described above. Table XIII presents the results.

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The third column of the table is obtained by multiplying the figures of the second column by the factor .826, as described on page 106.

If there were absolute agreement between the tests of relative nitrogen availability and relative nitrogen solubility in pepsin solution, the figures in the third column should be identical with the corresponding figures in the first column. There appears to be no satisfactory agreement between the two.

TABLE XIII.—COMPARISON OF NITROGEN AVAILABILITY BY MAIZE AND SOLUBILITY IN PEPSIN-SOLUTION.—MIXED FERTILIZERS.

	Relative Availability.	Solubility in Pepsin-Solution.	Relative Solubility.
II	52.9	75.3	62.2
V	51.4	64.0	52.8
XI	49.7	73.2	60.5
XII	46.4	67.4	55.7
XVI	39.6	55.0	45.4
XVIII	42.9	83.2	68.7

III. ON THE SOLUBILITY BY PUTREFACTION OF THE NITROGEN OF RAW MATERIALS USED AS FERTILIZERS.

The rapidity with which a nitrogenous substance decomposes by the action of microbe life, under favorable conditions, gives some indication of the value of the material as a source of nitrogen supply to growing plants. Thus leather, an animal tissue rendered proof against rapid decay by tanning, is inert as a fertilizer; but the untanned tissue, which decays readily, is a source of nitrogen available to plants.

Yet the compounds formed from different nitrogenous materials during decay differ in character and are probably not all equally available as plant food.

So that the value of a given nitrogenous substance as a source of plant-nitrogen depends both on the rapidity with which it decomposes in the soil and the nature and relative amount of the substances which are first formed from it (whether ammonia, amido-bodies, ptomaines, nucleins, etc.).

In continuation of work described in our Report for 1893, pages 223 and 228, samples of the same raw materials which have been tested by vegetation experiments, as just described, pages 94

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to 96, and page 101 and by pepsin-solution, pages 105 to 108, have also been compared as regards the solubility of their nitrogen under putrefaction.

The method followed was the same described in the Seventeenth Report of this Station, 1893, page 228.

It was in brief as follows:—In a flask of sufficient capacity the substance suspended in water, containing a small quantity of tobacco ashes and having a *very* slight alkaline reaction, and sterilized by boiling, was inoculated with an extract of mixed manure and putrefying meat.

The flask was kept at 30°–40° C. for four weeks. The extent of decomposition was determined after two weeks and again after four weeks, as shown in Table XIV, which presents the results of the experiments in detail.

Under this putrefactive process which was certainly most favorable to rapid decomposition those forms of nitrogenous matters which are most valued as fertilizers (excepting tankage) had yielded up a half of their nitrogen or more in form of ammonia, and a considerably larger proportion of it had become soluble in water.

During the experiment in some cases a considerable quantity of nitrogen escaped from the flasks, presumably as carbonate of ammonia.

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TABLE XIV.—SOLUTION OF ORGANIC NITROGEN DURING PUTREFACTION.

	Dried Blood.	Castor Pomace B.	Linseed Meal.	Cotton Seed Meal.	Castor Pomace A.	Horn and Hoof.	Dry Fish.	Tankage.	Leather and Garbage.	Raw Leather.	Steamed Leather.	Roasted Leather.	Dissolved Leather.
Nitrogen in Sample	13.20	5.56	5.75	7.38	5.40	15.59	9.34	4.17	7.26	6.61	7.11	10.24	2.07
After 14 days. Nitrogen in Solution as Ammonia	6.68	3.18	2.42	3.52	2.60	3.05	4.72	1.66	1.96	.36	.68	.18	.68
" " " organic	2.29	.93	.72	1.02	1.10	2.63	1.64	.63	1.42	.66	1.09	.10	.12
Total	8.97	4.11	3.14	4.54	3.70	5.68	6.36	2.29	3.38	1.02	1.77	.28	.80
Per cent. of the total Nitrogen gone into Solution	68.0	73.9	54.6	61.5	68.5	36.4	68.1	55.0	46.5	15.4	24.9	2.7	38.6
After 30 days. Additional Nitrogen in Solution as Ammonia	.61	.17	.15	.35	.16	.80	.03	.48	.35	.65	.07	.08	.00
Additional Nitrogen in Solution, organic	.57	.29	.58	.12	.26	.24	.78	.15	.26	.27	.07	.06	.07
Per cent. of total Nitrogen gone into Solution since the previous filtration	8.9	8.3	12.7	6.3	7.7	6.6	8.6	15.1	8.4	13.9	1.9	1.3	3.3
Per cent. of total Nitrogen in Solution as Ammonia	55.2	60.2	44.7	52.4	51.1	24.7	50.8	51.3	31.8	15.3	10.5	2.5	32.8
Per cent. of Nitrogen in Solution, organic	21.6	21.9	22.6	15.4	25.2	18.4	25.6	18.7	23.1	14.1	16.3	1.5	9.1
" " " escaped*	14.6	1.9	9.1	5.9	8.9	4.9	8.0	3.6	4.2	0.0	1.3	8.1	0.1
" " " left undissolved	8.6	16.0	23.6	26.3	14.8	52.0	15.6	26.4	40.9	70.6	71.9	87.8	58.0
	100 0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* Escaped into the air as ammonia or other gas.

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To compare these results with those given in Table XII, page 107, the solubility of dried blood under putrefaction (91.4 per cent.) is called 77.1 per cent. as in Table XII, and the solubilities of all the other materials are *correspondingly* reduced. Hence if there were perfect agreement between the relative solubility in pepsin solution and under putrefaction there would be perfect agreement between the corresponding figures. The comparison appears in Table XV.

TABLE XV.—COMPARISON OF NITROGEN AVAILABILITY BY MAIZE, SOLUBILITY IN PEPSIN-SOLUTION, AND SOLUBILITY IN PUTREFACTION.

	Relative Availability.	Relative Solubility	
		In pepsin-solution	By putrefaction.
Dried Blood	77.1	77.1	77.1
Castor Pomace B	85.2	76.5	70.8
Linseed Meal	79.6	75.6	64.4
Cotton Seed Meal	75.5	73.8	62.1
Castor Pomace A	73.9	71.0	71.8
Horn and Hoof	72.1	28.9	40.4
Dry Fish	69.8	66.9	70.9
Tankage	67.9	56.2	62.1
Leather and Garbage	30.8	33.8	49.8
Raw Leather	0.0	7.1	24.8
Steamed Leather	6.2	16.8	23.7
Roasted Leather	6.3	7.0	10.3
Dissolved Leather	79.3	5.3	35.4

The results show no satisfactory agreement with the results obtained either by vegetation experiments or by solubility in pepsin.

The relative solubility in pepsin-solution has this year agreed much more nearly with the relative availability as determined by vegetation tests, than has the relative solubility by putrefaction.

A further study of these methods is planned in the coming year.

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FIRE-BLIGHT.

(*Micrococcus amylovorus*, Burr.)

By Wm. C. Sturgis.

For some years there has been prevalent in certain parts of the country, a bacterial disease affecting pear, apple, and quince trees, and known familiarly as "Fire-blight" or "Twig-blight." This serious disease early engaged the attention of specialists, and now its nature and course have been accurately determined, and a line of treatment recommended which promises good results.

For the past two years I have watched the gradual spread of this disease, and the time has come when it should receive the serious attention of Connecticut fruit-growers. It will be well therefore to consider briefly the nature of this disease, its contagious character, and the means which may be taken to check its ravages.

This disease has been known for the past hundred years, the first recorded paper upon the subject bearing the date 1794. At that time it was attributed to a borer, and for eighty years the theories advanced as to its cause were almost as numerous as were the observers. The two theories which received the most general acceptance were (1) that the disease was primarily due to the borer, *Scolytus Piri*, and (2) that it was due to winter freezing of the sap whereby a poison was engendered which destroyed the young shoots the following season. It was not until 1880 however, that any theory was advanced, based upon accurate scientific observation. In that year Prof. Burrill published the results of his investigations tending to prove that "fire-blight" was directly caused by a specific bacterial organism of minute size which he named *Micrococcus amylovorus* from its destructive effects upon the amylum or starch-contents of the cells attacked. The admirable work of Prof. Arthur in 1884 and subsequent years, has established this fact beyond doubt. Not only were the bacteria found in every case, filling the cells and exuding on the exterior of the parts affected, but the inoculation of sound trees with pure virus obtained from diseased trees resulted in the transfer of the disease in a virulent form. That the disease was due to the bacteria themselves and not to any soluble poisonous substances or ptomaines excreted by them, was abundantly proved by the fact that trees inoculated with the

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liquid obtained by filtering a pure culture of the bacteria through a porous earthenware cell, and thus freeing it from the bacteria, failed to produce the disease; while trees inoculated with the unfiltered liquid still containing the bacteria, invariably showed abundant evidences of the disease in the course of a few days.

Trees liable to the disease.

In this neighborhood "fire-blight" is most commonly found upon pear trees, but it also attacks the apple and the quince, and may be mutually transferred by inoculation or by the natural means of infection. It has also been proved by Arthur that the common Service-berry (*Amelanchier Canadensis*), the English Hawthorn (*Crataegus Oxyacantha*) and the Evergreen Thorn (*C. Pyracantha*) are subject to the disease.

Appearance of the disease.

The first indication of "fire-blight" is seen in the blackening of the leaves of young shoots; when this symptom becomes manifest, the disease has already been in progress for two or three weeks. Later the twigs themselves become blackened and dead and in severe cases, especially in damp weather, there appears upon the surface of the affected parts a slimy film or exudation. Occasionally the disease makes its appearance on the larger branches of the trees, or even upon the trunk, when in outward appearance it suggests the physiological injury commonly known as "sun-burn" or "sun-scald." Finally it may in rare instances attack the fruit, producing upon the surface watery ulcers accompanied by a brown discoloration and decay. In all cases the disease is characterized by a more or less distinct putrefactive odor.

Mode of Infection.

The bacteria causing "fire-blight" are extremely minute, oval or rod-shaped organisms, occurring in vast numbers in the diseased tissues, and possessing to a slight degree the power of motion. When separated from the tissues, they may be grown in various liquids such as infusions of hay, starch, corn-meal, cooked pear, manure, or garden soil, or upon gelatine containing nutrient substances; in other words they may live and multiply indefinitely upon dead vegetable matter in the presence of moisture. This fact has an important bearing upon the spread of the disease.

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The bacteria as they exude from the diseased tissues are washed down by the rain, or fall to the ground with the leaves and twigs containing them; upon the decomposing vegetable matter surrounding them they multiply with rapidity, and when dry are disseminated by the wind, or by currents of water. Borne by the air in spring time they find a lodgment upon the neighboring trees; on the moist surfaces of the delicate parts of the flowers and upon the growing, succulent tissues of the young twigs and leaves, they find favorable conditions for growth, soon enter the tissues, and in the course of a few weeks give external evidence of their presence in blackened leaves and shoots. According to Arthur and Waite the moist surface-tissues of the flowers and especially of the nectaries afford suitable conditions for the growth of the bacteria, which multiply in the nectar and are thence carried by insects from flower to flower and also to other trees. Waite is authority for the statement that an artificial epidemic of blight may be started by infecting a few trees on the edge of an orchard, and allowing free access of insects; and that protecting the flowers from visits of insects will protect from blight. This is only partially true as it leaves out of consideration agencies of infection other than insects. Very tender tissues and a moist atmosphere are the primary requisites for the inception of the disease, and when it makes its appearance on the branches or the trunk it may usually be traced to spurs at the base of the limbs, or to adventitious shoots arising upon the trunk in spring. The stings of insects, open wounds whether caused accidentally or by the pruning knife, and in fact any injury which exposes the tender, growing tissues, may admit the germs and thereby indirectly cause the disease.

From the foregoing facts we may arrive at some conclusions which will be of value in considering practical methods of treatment.

(1) Inasmuch as moisture and tissues in process of active growth are conditions peculiarly favorable to the development of the bacteria, we should look for the first symptoms of the disease in the spring, and especially in damp weather.

(2) We are justified in concluding that anything which tends to force excessive growth, or the development of tender shoots upon the limbs or trunk, tends equally to the inception of the disease.

(3) That open wounds of any description whereby the delicate tissues are exposed may give access to the germs of disease.

(4) That the disease will spread outward from the locality first infected, in the direction of the prevailing winds.

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(5) That varieties making slow growth, and characterized by density of the tissues will be least susceptible to the disease.

(6) That the disease is mutually communicable between the pear, apple, quince, and hawthorn.

Means of Prevention.

It is evident that in the case of "fire-blight" fungicides will be of less value than with other fungous diseases. The organisms producing the disease are so minute, they occur in such enormous numbers, and gain access to the plant through tissues either so slightly exposed as to render it impracticable to reach them with a spray, or so delicate as to be susceptible to injury from any fungicide used, that we must look to other means of prevention or eradication.

Careful examination of the orchard from time to time during the spring, and in early summer two or three weeks after the opening of the flowers, will enable anyone to recognize the first visible symptoms of the disease in the blackened leaves of the young shoots. If such shoots are at once removed by cutting them off at least six inches below the lowest point where the disease is manifest, much will have been done to prevent its recurrence. It is hardly necessary to say that it is essential to do this work early and thoroughly, even if by so doing the greater part of the new growth is destroyed; and also that the diseased shoots should be burned to ashes at once. After the middle of July there is but little danger of the active spread of the disease from one tree to another since the bacteria are then within the tissues enclosed by the bark, or if they appear externally are held together by the gummy exudation; and furthermore at that season there are but few points where the surface-tissue is sufficiently tender to allow of penetration on the part of the bacteria.

Vigorous pruning then, and the burning of all diseased parts, is the surest means of eradicating the disease when once it has gained a foothold. To prevent a second attack through the tissues exposed by pruning, the wound should be at once sealed up either with grafting wax, or better still with oil shellac to which is added a little flowers of sulphur and a few drops of carbolic acid. This forms a more or less viscous liquid and can be readily applied with a paint brush.

Secondly, care should be taken, especially in the case of trees which tend to grow rapidly and to develop soft, watery shoots, not to force growth in the spring by the application of fertilizers in

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unusual quantities. The continuous and regular application of fertilizing materials to land already enriched will tend to produce a slow but continuous growth, and the young shoots will ripen as they develop. Such fertilizers as wood ashes and ground bone are to be recommended for inducing the maturing of the wood.

Those who desire more detailed information regarding the nature of "fire-blight" are referred to the original publications of Burrill and Arthur.*

Prevalence of "Fire-blight" in Connecticut.

From my own observations and from information received from others it would seem that "fire-blight" is not as yet very widely spread throughout the State. It has been reported as causing slight damage to pears and quinces at Bristol, Hartford Co.; it has done considerable damage to pears, and is on the increase, in the neighborhood of Meriden; during the past season it was very prevalent upon pears, apples, and quinces near Berlin, though not previously reported from that locality; and it attacked quinces here and there in the vicinity of New Haven. It is doubtless far more widely spread than would appear from the reports received, since it has not yet been generally recognized by the farmers of the State as a distinct and specific disease.

A "FIRE-BLIGHT" OF PLUM TREES.

By Wm. C. Sturgis.

About the middle of July last it was reported that a blight had attacked a large orchard of plum trees at East Hartford, and upon visiting the orchard I was at once struck by the resemblance of the blighted trees to pear trees affected with "fire-blight." The orchard occupied comparatively high, well-drained land, the soil was sandy, very light, and at that time extremely dry. The trees were three-year old stock of the Spaulding and Abundance varieties. The disease had attacked only the former variety, but had done great injury to the young wood. The young shoots

* Burrill, T. J., Proc. Amer. Assoc. Adv. Sci., Vol. xxix, 1880, p. 583.
Trans. Ill. Hort. Soc., 1883, p. 46.
Arthur, J. C. Rep. N. Y. Agr. Exp. Sta. for 1884, p. 357; Ibid, 1885, p. 241; Ibid, 1886, p. 275 (to which is appended a complete bibliography of the subject to date) Proc. Phila. Acad. Nat. Sci., 1886, p. 322.

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and leaves were black, and bent over as though wilted. The leaves were dry and crisp, the twigs themselves flexible and somewhat of the consistency of soft sealing-wax. The blight had evidently started at the extreme tips of the twigs and had extended downwards a distance of from six to ten inches. In this case infection must have taken place through the young leaves, as no flowers had been produced. A number of the diseased twigs were collected for microscopic examination, and directions were given that all the affected tips should be removed and burned. On Aug. 2d I wrote asking for more samples of the disease from the same orchard, but was informed that the disease had not reappeared upon either variety and that all of the trees appeared to be healthy. Meantime specimens examined in the laboratory showed unmistakably the presence of bacteria in the diseased tissues, and there was also upon the leaves a species of Cladosporium, though this latter was apparently a common saprophytic fungus in no way connected with the disease. Specimens were sent to Prof. Arthur who kindly examined them and wrote as follows: "The appearance of the twigs is certainly that of pear blight, but I have never seen genuine pear blight attacking any of the stone fruits. I do not have any difficulty in finding the bacteria in quantity in the diseased tissues. I should say that the disease is likely to be bacterial in its nature, but not to be identical with pear blight."

Attempts to secure pure cultures of the bacteria proved unavailing, and a like result attended all efforts to inoculate pear, apple, and quince trees with virus from the plum twigs. Lack of material prevented further study of the disease. Meanwhile it is well to note the presence of this disease which, if permitted to run its course unchecked, is capable of doing very serious injury to plum stock.

EXPERIMENTS ON THE PREVENTION OF POTATO SCAB.

By Wm. C. Sturgis.

The use of corrosive sublimate in the treatment of potato scab was first suggested as the result of definite experiments, by Prof. Bolley in 1891.* The success attending those experiments led to

* N. Dak. Agr. Exp. Sta., Bull. 4, Dec. 1891.

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others in various localities East and West, of which the most conclusive were those conducted by the Rhode Island* and Michigan† Stations in 1893.

Since these and other publications upon the subject are not readily accessible to the majority of farmers, it was thought advisable to repeat the experiment in a locality and upon a scale which would enable Connecticut farmers to judge for themselves regarding the value of the treatment. For this purpose a piece of land was secured through the coöperation of Mr. W. H. Olcott of South Manchester. The land adjoined Mr. Olcott's farm and measured about three-quarters of an acre; it was old meadow which had not been cultivated for many years and had probably never borne potatoes. A slight slope toward the west insured good drainage, and the soil was a sandy or gravelly loam. The rows were laid out east and west across the lot, and were, on an average, 126 feet in length. The land was prepared by ploughing and turning the sods under, harrowing, and lining out with the plough.

The course of treatment was as given by Prof. Bolley, as follows:

"Dissolve corrosive sublimate (bichloride of mercury) in water at the rate of two and one-fourth ounces of the chemical to fifteen gallons of water. Immerse all potatoes to be used for seed purposes in this solution one and one-half hours, after which they may be cut and planted as usual.

NOTES: Corrosive sublimate is a strong poison; great care should be taken that none of it is taken into the stomach.

To insure rapid solution, all the chemical may conveniently be dissolved in a few gallons of hot water.

This chemical corrodes metallic substances and should therefore be mixed in wooden vessels.

A large barrel or hogshead will be found a convenient vessel in which to dip the potatoes.

A loosely woven sack (coffee-sack), will be found suitable for the dipping purposes.

If the potatoes are very dirty it will be found expedient to wash them before treatment.

After dipping spread the potatoes about so that they will dry quickly."

The seed used for planting was of three grades, (1) very scabby, the tubers being completely covered with the scab spots and quite unmarketable; (2) fairly scabby, showing a decided amount of scab but still marketable at low prices; (3) clean,

* R. I. Agr. Exp. Sta., Bull. 26, 1893.

† Mich. Agr. Exp. Sta., Bull. 108, 1894.

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either completely free from any trace of scab, or exhibiting only small, isolated points of infection.

The seed was planted May 19th, 20th, and 21st; a month later the plants were making a good growth. The points upon which information was particularly desired were, (1) the effect upon the crop of the use of clean seed as compared with scabby seed, all other conditions being the same; (2) the effect of the use of barnyard manure as compared with commercial fertilizer; (3) the effect of treating the seed before planting, with corrosive sublimate, as compared with the product from seed not treated, the plants in both cases being raised on barnyard manure; and (4) the same, with the exception that the plants were raised on commercial fertilizer. No account was taken in the experiment of the varieties of seed used. It was selected solely with regard to its scabbiness or its freedom from scab, but the greater part consisted of New Queen, with some Early and Late Rose.

The land was divided into eight plots, separated by blank rows or by rows planted with clean seed and not considered in formulating the results.

The accompanying table shows for each plot the character of the seed, whether clean or scabby; the variety; the number of rows in the plot; the fertilizer used; the treatment or non-treatment of the seed with corrosive sublimate; the yield of two average rows from each plot; and the character of the crop. It will be seen that the experiment illustrates several minor points as well as those which were primarily important. The utmost care was exercised in grading the product. Every tuber was freed from dirt as thoroughly as was possible without washing, and carefully examined. If it showed the scab in quantity sufficient to render it practically unmarketable, it was classed as Grade 3; if slightly scabby, but marketable, or such as might generally be used as seed, it was classed as Grade 2; Grade 1 included only such tubers as showed, after careful examination, not the slightest trace of scab. Each grade in each plot was kept separate, measured, weighed, and photographed.

About the middle of July the tops were attacked by "early blight" (*Macrosporium Solani*, E. & M. ?), and they also suffered somewhat from sunburn, the weather being excessively hot and dry, and from the depredations of flea-beetles, but the damage was not sufficient to vitiate the results.

The potatoes were dug Sept. 25th and 26th, and, as has been said, two sample rows were taken from each plot for comparison.

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Referring now to the table, a comparison between plots B^2 and D illustrates the result of planting clean seed as compared with scabby seed, there being no treatment in either case with corrosive sublimate. The character of the crop as regards the amount of scab shows surprisingly little difference, the difference, however, being in favor of the clean seed. Very similar results obtain in a comparison between the effects produced by planting clean seed and scabby seed, both being treated before planting with corrosive sublimate. Thus a comparison between plots B^1 and C shows that the clean seed treated produced only 7% more clean tubers than the scabby seed treated. The scabby seed produced 6% more tubers which were fairly scabby, and the percentage of very scabby tubers was in both cases the same. Undoubtedly, as will be seen later, the large amount of scab present on all four plots B^1, B^2, C, and D, was due to the presence of the barnyard manure, and we may conclude, so far as a single experiment may be taken as an indication, that the treatment with corrosive sublimate avails but little in the presence of barnyard manure. It should be stated that in all cases where barnyard manure was used, the seed was planted in direct contact with the manure both above and below, thus giving to the germs of the scab fungus presumably resident in the manure, the most favorable opportunity for attacking the tubers. We must also bear in mind in forming our conclusions that whereas all barnyard manures form a medium favorable to the growth of the scab fungus, there may be a very marked difference in the amount of the fungus present, a difference depending upon the season at which the manure is made and stored, the substances which have entered into its composition, and its liability to infection from diseased potatoes fed to stock or from the refuse of a diseased crop.

We may obtain more trustworthy data regarding the effect of barnyard manure on the amount of scab, as compared with commercial fertilizer, by contrasting plots A and B^3, the seed in neither case having been treated with corrosive sublimate. On both plots the crop shows the presence of scab, notwithstanding the fact that perfectly clean seed was used and that the land was presumably free from the scab fungus, but whereas the crop raised upon commercial fertilizer shows but 4% of very scabby tubers, one-third of the crop raised on barnyard manure is very scabby. A like difference is seen between the yield of fairly scabby and of clean tubers on the two plots. In this case cer-

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tainly the use of barnyard manure has very materially increased the amount of scab, even upon clean land and with clean seed. We may fairly conclude then, that the use of barnyard manure is decidedly conducive to scab.

We may go one step further and compare the effect of barnyard manure and of commercial fertilizer used in connection with scabby seed treated with corrosive sublimate. Plots C, H, and B^2 present figures for comparison upon this point. Plot C offers every opportunity for a large percentage of scab except that the seed has received a presumably preventive treatment. Leaving the treatment out of account, we should expect a far larger percentage of scab than in the case of plot B^2, for example, where clean seed was used. As a matter of fact however, the results show only half as large a percentage of very scabby tubers and 5% more of clean tubers. In the case of plot C then, the treatment has been of undoubted value in lessening the amount of scab even under conditions otherwise most favorable to its spread.

But that the treatment has not been able entirely to overcome the conditions induced by the presence of the barnyard manure, becomes evident upon a comparison of plots C and H. Upon plot H, the treatment of the seed with corrosive sublimate has produced from scabby seed upon commercial fertilizer, a crop practically free from very scabby tubers, and showing only 15% of tubers at all affected with scab. With this favorable showing, the 15% of tubers rendered unmarketable by scab on plot C, evidently the result of the manure, is in marked contrast. There is good reason to believe that had the seed upon plot H been clean, there would have been no trace of scab upon the crop.

We may conclude then, that while the effect of barnyard manure upon the spread of scab may be partially counteracted by treating the seed with corrosive sublimate before planting, the use of either manure or scabby seed tends to induce scab upon the tubers.

Finally, we may reach more definite conclusions upon the question of the value of corrosive sublimate as a preventive of scab, by a comparison between plots G or H, and F. On these three plots scabby seed was planted in connection with commercial fertilizer. The seed used upon plots G and H was treated with corrosive sublimate before planting; that upon plot F was not so treated, but was merely washed clean with water. Here the beneficial effect of the treatment is very evident. Plot F shows 13%

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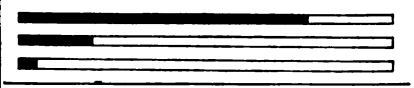
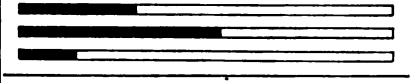
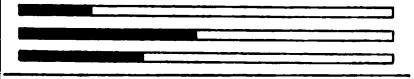
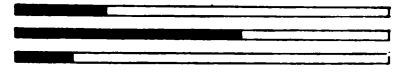
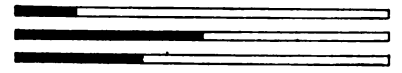
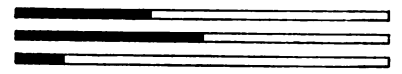
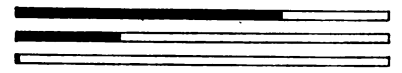
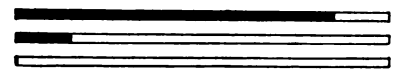
Plot.	Quality of Seed.	Variety of Seed.	Fertilizer.	Treatment of Seed.	Total yield in pounds from two sample rows.	Quality of Crop.*	Percentages of Grades 1, 2, and 3 represented graphically.
A.	Clean.	Early Rose and Late Rose.	Commercial.	0	148¼	1. 114 lbs. = 77 per cent. 2. 28¼ " = 19 " 3. 6 " = 4 "	
B¹.	Clean.	Late Rose.	Barnyard Manure.	Corrosive sublimate.	176¼	1. 55 lbs. = 31 per cent. 2. 94 " = 54 " 3. 27¼ " = 15 "	
B².	Clean.	Early Rose.	Barnyard Manure.	0	132	1. 25 lbs. = 19 per cent. 2. 62½ " = 47 " 3. 44½ " = 33 "	
C.	Scabby.	New Queen.	Barnyard Manure.	Corrosive sublimate.	144	1. 34 lbs. = 24 per cent. 2. 87½ " = 60 " 3. 22½ " = 15 "	
D.	Scabby.	New Queen.	Barnyard Manure.	0	110½	1. 17 lbs. = 16 per cent. 2. 56½ " = 50 " 3. 37 " = 34 "	
F.	Scabby.	New Queen.	Commercial.	0 Washed.	97	1. 35 lbs. = 36 per cent. 2. 49 " = 50 " 3. 13 " = 13 "	
G.	Very Scabby.	New Queen.	Commercial.	Corrosive sublimate.	148¾	1. 105 lbs. = 71 per cent. 2. 41½ " = 28 " 3. 2¼ " = 1 "	
H.	Scabby.	New Queen.	Commercial.	Corrosive sublimate.	163⅜	1. 139 lbs. = 85 per cent. 2. 24 " = 15 " 3. 6 oz. = —1 "	

* Graded according to amount of scab on tubers: 1 = 1st quality, with no trace of scab. 2 = 2nd quality, fairly scabby but marketable. 3 = 3rd quality, very scabby, unmarketable.

For effect of scabby seed, compare plots B² and D (not treated), Or plots B¹ and C (treated.)
For effect of manure, compare plots A and B² (clean seed), Or plots C and H (scabby seed.)
For effect of treatment, compare plots B¹ and B² (manure), Or plots G or H and F (commercial fertilizer.)

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of very scabby tubers as compared with 1% from plot G, and only one tuber from plot H, while the percentage of clean tubers from plot F is only half as large as that from plot G. Plot F shows 63% of scabby tubers, plot G 29%, and plot H only 15%. The difference between plots G and H is to be attributed to the seed; on plot H fairly scabby seed was used, while for plot G pains were taken to secure seed so thoroughly infested that there was not a spot half an inch square which was free from scab. That under such circumstances only 1% of the tubers proved to be as scabby as the seed planted, is a fact which strikingly attests the value of the treatment. Plots B^1 and B^2 illustrate the same point though in a less marked degree, owing to the fact that the crop was contaminated by barnyard manure. Even in this case however, there are but half as many very scabby tubers from the treated seed as from the untreated, and 12% more of clean tubers.

We are now in a position to sum up our conclusions from this experiment.

(1) The character of the seed as regards scab, has much to do with the character of the crop. As a rule scabby seed will produce a scabby crop, other things being equal; and the amount of scab on the crop will be directly proportional to the amount of scab on the seed.

(2) In the presence of barnyard manure the tubers tend to become scabby to a degree not markedly affected by the character of the seed, whether clean or scabby.

(3) Treating the seed with corrosive sublimate before planting, avails to some extent in preventing scab when barnyard manure is used, though the amount of scab present under such circumstances may vary with the character and composition of the manure. Further experiments may compel a modification of this conclusion.

(4) The use of commercial fertilizer is not a preventive of scab, but when clean seed is planted on clean land the amount of scab is far less with commercial fertilizer than with barnyard manure. The same is true in a lesser degree when scabby seed is used.

(5) Treating scabby seed with corrosive sublimate before planting tends to decrease the amount of scab upon the tubers even in the presence of barnyard manure.

(6) The treatment of scabby seed with corrosive sublimate before planting, may produce a practically clean crop if commercial fertilizer be used, and the land be clean. Clean seed under like conditions will certainly do so.

Results obtained on the Farm of Mr. Bidwell.

It will be of interest to note certain results attending the use of corrosive sublimate in the treatment of seed potatoes on the

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farm of Mr. Dwight Bidwell of South Manchester. In this case the experiment was conducted without our assistance and for the purpose of securing as clean a crop as possible, rather than of affording a distinct proof of the value of the treatment. The results therefore are merely indicative and present no means of comparison between the product from seed treated and that from seed not treated.

Field No. 1 consisted partly of reclaimed swamp land and partly of a sandy loam; it had not previously borne potatoes and hence was presumably free from scab. It was heavily fertilized with stable manure and tobacco stems, thoroughly worked in. The seed was treated with corrosive sublimate, and produced a practically clean crop. In this instance the treatment seems to have prevented infection from the manure.

Field No. 2 comprised an underdrained swamp occupying about one-half of its area, the remainder being a dry sandy or gravelly knoll. During the summer of 1893 it had borne a crop of scabby potatoes. It was fertilized with stable manure and tobacco stems. The seed was treated with corrosive sublimate, but a portion of it failing to come up, that part was replanted with seed which received no treatment. The crop showed 75% of scabby tubers. In this case the land was undoubtedly thoroughly infested with scab, and a comparison of the results with those obtained on field No. 1, would lead to the impression, though definite proof is wanting, that the scabby quality of the crop was due primarily to the infested soil accentuated by the fact that the seed used in replanting received no preventive treatment. At least we may fairly conclude that the use of land known to be infested with the scab fungus from a former crop, is to be avoided.

Field No. 3 consisted of turf land, ploughed under and harrowed. It received commercial fertilizer sown between the drills at the rate of 1200 pounds per acre. The seed was treated, but it became necessary to replant a portion of the field, and for this purpose seed was used which was slightly scabby and received no treatment. The crop from this field showed from 15% to 20% of scabby tubers. In this case it seems probable that the loss was occasioned by the use of the scabby seed.

From these facts it is evident that in order to avoid scab we must observe certain precautions.

Select if possible, clean land, that is land which has not previously borne a scabby crop of potatoes, beets, or turnips.

Select only the cleanest seed for planting.

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Avoid the use of barnyard manure on potatoes if practicable.

In any case, and especially if scabby seed or barnyard manure must be used, treat the seed with corrosive sublimate before planting, according to the directions given on p. 119.

Corrosive sublimate may be bought at any apothecary's for 10 to 12 cents per ounce, three ounces will be sufficient to treat enough seed to plant five acres or more. The labor of preparing the solution and treating the seed is very slight, the potatoes require no further treatment for scab during their period of growth, and the treatment involves no expense in the way of apparatus.

In view of these facts there is no reason why this treatment against potato scab should not be universally adopted by growers of potatoes, and the percentage of scabby tubers in our markets and cellars be reduced to a minimum.

The experiment conducted this year will be continued another season with the view of confirming the facts already ascertained, and of securing more information upon other cognate questions of importance.

SCAB UPON TURNIPS.

By Wm. C. Sturgis.

A form of scab proved to be identical with that occurring upon potatoes has been recorded by Bolley, upon beets.* "With the beet it does not as a rule result in cavities, but the corky formations are very extensive. It has its inception at the points where the pith rays touch the surface. It is at these points that the rootlets arise from the beet, hence the scabs injure many points on the surface that might else be occupied by the fine roots that supply nourishment. In the past few days Swedish turnips, carrots, and cabbage roots have been procured in the market, all apparently affected with the same disease. It is quite a common appearance on the turnips and I have little doubt of its identity."

During the month of November specimens of turnips were sent to the Station from South Manchester, bearing numerous scabs as seen in the accompanying illustration, Plate IX. These turnips were grown upon land which for the two years preceding the planting of the turnips, had borne potatoes, and I am informed that the potatoes were more or less scabby.

* N. Dak. Agr. Exp. Sta. Bull. 4, p. 15, with plate, Dec. 1891.

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PLATE VIII. Fir Twigs injured by Fir Mite.

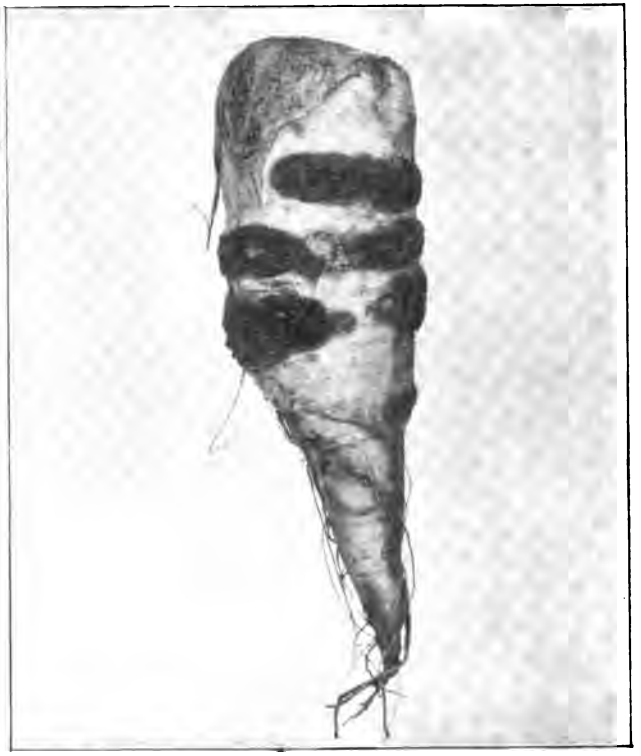

PLATE IX. Scab on Turnips.

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The attention of farmers is therefore called to the fact that the scab of potatoes is communicable to turnips, beets, and possibly to other root-crops, and that it is unsafe to plant such a crop upon land known to contain the germs of the scab-fungus.

The treatment of turnips for scab presents difficulties of which there is at present no solution. Care in the selection of the land, the use of commercial fertilizers, and rotation with other than root-crops are precautionary measures which may be recommended.

NOTES ON THE "EARLY BLIGHT" OF POTATOES.

By Wm. C. Sturgis.

Public attention was first called to this disease by Humphrey, who in the Annual Report of the Mass. Agr. Exp. Station for 1891, reported its occurrence on potatoes in the neighborhood of Hadley, Mass. He also records "the constant presence in the diseased spots of mycelium, from which were developed, on the lower surface of the leaves, spore-threads and spores of the form-genus *Macrosporium*."

Almost simultaneously with the publication of this report, Jones reported a similar disease from Vermont,† and Chester noted it in Delaware.‡ The former recorded no fungus as associated with the disease, and suggested that it might be identical with a bacterial blight of potatoes first described by Burrill.§ He furthermore stated with regard to spraying, that but little if any benefit was derived from the use of Bordeaux mixture and other fungicides. Chester, on the other hand, found a species of *Macrosporium* associated with the disease, and identified it with *M. Solani*, E. & M., which occurs also upon the tomato and "Jimson weed" (*Datura Stramonium*), and he has further recorded the results of inoculations proving that the fungus is a true parasite and can be artificially transferred from the potato to the tomato. He quotes Galloway as recommending from experience the use of Bordeaux mixture in checking the trouble.

But that the diagnosis of this peculiar disease is not yet complete, is shown by the later observations of Jones. As the result of the examination of a number of diseased potato leaves, he

* Vt. Agr. Exp. Sta., Rep. for 1892, p. 67.

† Vt. Agr. Exp. Sta., Rep. for 1891, p. 131. Also Bull. 28, p. 25, Apr. '92.

‡ Del. Agr. Exp. Sta., Rep. for 1891, p. 58. Also Bull. xv, p. 13, Jan. '92.

§ Proc. 11th An. Meet., Soc. Prom. Agr. Sci. 1890, p. 21.

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states,* "We are still in some doubt as to the cause of part of this trouble, and do not think that any one thing is wholly responsible. In many leaves examined we were unable to find any trace of fungous attack. In the large majority however, we found a *Macrosporium*, apparently *M. Solani*, E. & M. The general association of this fungus with the disease, leaves little doubt in our minds that it was a cause of a large part of the trouble last summer." Regarding treatment for the disease, he states that "in so far as this early blight is caused by the attacks of the *Macrosporium*, we may hope to hold it in check by spraying," and he recommends Bordeaux mixture for this purpose.

Finally Galloway states,* "For blight (*Phytophthora*) and the *Macrosporium* disease nothing so effective as the Bordeaux mixture has been found."

This evidence as well as our own experience leads us to ask whether the so-called "early blight" of potatoes is always directly traceable to fungous attack; and if not, whether Bordeaux mixture is of much practical value in treating vines which, while evidently blighted, show no trace of the *Macrosporium*. Observations made last year, and commented upon briefly in our Report for 1893, failed to show any trace of fungi in the majority of diseased leaves examined, yet the gross appearance of the leaves was exactly that described by Jones and Chester in the case of "early blight,"—small dead spots, dry and brittle in texture, usually appearing first at the tips and edges of the leaflets, and marked with dark, concentric rings; spreading slowly, especially in very hot weather; usually originating at the edges of the eroded pits caused by the flea-beetle, (*Crepidodera* sp.).

During the season just past, the weather from the early part of June to the middle of July was extremely dry, a burning sun was frequently accompanied by high winds, and potatoes suffered severely. A large number of specimens of blighted leaves were obtained by correspondence and otherwise, and were carefully examined for the *Macrosporium*. The majority of specimens showed no trace of any fungus in the tissues; in a few instances the *Macrosporium* was found in small quantities, and in one case there was an abundance of a species of *Cladosporium* occupying the blighted areas, but evidently existing saprophytically on tissues destroyed by some other agency. Traces of the flea-beetle were abundant in all of the specimens examined.

* U. S. Dept. Agr., Farmer's Bull. No. 15, 1894, p. 6.

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In view of such conflicting evidence, a few additional facts may be of interest.

We have seen that the blight has accompanied in every case reported, injuries induced by the flea-beetle, and so far as I am aware, there have been no instances of early blight as a specific disease attacking sound leaves to any marked degree. It is well known that the attacks of the flea-beetle are most severe in dry, hot weather, under which conditions the early blight seems also to prevail. Opinions differ regarding the value of Bordeaux mixture, some observers claiming that it is but slightly, if at all, effective against the trouble, others that in so far as it is caused by a fungus there is a possibility of holding it in check by spraying with Bordeaux mixture, while others again state that for blight (*Phytophthora*) and the *Macrosporium* disease nothing so effective as the Bordeaux mixture has been found. It is significant however, that there are no published reports giving distinct and accurate comparative results of experiments in the treatment of the "early blight" as a specific disease. The results in this direction have been as a rule obtained incidentally in the course of experiments designed to test the value of fungicides in the treatment of the mildew or rot (*Phytophthora infestans*).

Under date of July 11, 1894, an extensive grower of potatoes and manufacturer of fertilizers in Pittsburg, Pa., wrote me to the following effect. "For about six weeks there has been almost no rain; the weather has been very close, and sun hot. Under these conditions many potato fields have been wholly destroyed, those on sandy soil suffering most." My correspondent sprayed his potato vines during the drought with Bordeaux mixture, and "cultivated" frequently, a process frequently practiced and of great assistance in increasing the capacity of the soil for retaining moisture in dry weather; his vines made vigorous growth and held up throughout the drought, while those belonging to a neighbor, which were sprayed, but received no unusual cultivation, were a complete loss.

Specimens of blighted leaves received from this gentleman showed that the flea-beetle had been abundant, and on some of the specimens there were traces of *Macrosporium*. These facts seem to add probability to the theory that extreme heat and dryness, accentuated by lack of moisture in the soil, may induce the death of tissues at a distance from the roots (the tips and edges of leaflets); that this damage may be increased and even

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initiated by the attacks of predatory insects (flea-beetles) which partially destroy the tissues at certain points; and that finally in some cases a facultative parasite (a fungus which exists normally as a saprophyte upon dead tissues, but may under certain conditions attack living tissues and thus become a parasite) such as species of the genera *Macrosporium*, *Cladosporium*, etc., may attack the dead or dying tissue, and aggravate the trouble, while in other cases no such fungus attack is observable.

Such a theory seems to be in accordance with the facts observed —the appearance of "early blight" at a season usually marked by dry, hot weather; its prevalence during the extremely dry summers of the past two years; its slow progress, in marked contrast to most fungous diseases of the nature of blight, rot, etc.; the advantage gained by frequent shallow tillage, preventing the rapid evaporation of moisture from the soil; and finally the fact that in the majority of cases the injury from "early blight" is directly proportional to the damage done by the flea-beetle. There are two facts however, which, if established, would go far to prove the fungous character of "early blight." These facts are, (1) the value of a well-known fungicide in checking the trouble, and (2) the fact reported by Chester that sound potato leaves inoculated with *Macrosporium* spores exhibit in the course of a few days symptoms of the "early blight."

As regards the value of Bordeaux mixture in this case, it has already been noted that testimony upon this point is not unanimous, and various reasons may be assigned to account for its apparent efficacy. It is well known that the use of Bordeaux mixture, or in fact of any compound of copper, tends to increase the vigor of potato plants to a very marked degree, apart from any fungicidal action which it exercises. It is not improbable that the beneficial effect arising from its use in certain cases of "early blight," may have been in a measure due to this tonic action. Again, if the *Macrosporium* may become a parasite under certain conditions, just so far as those conditions prevail Bordeaux mixture would doubtless act as a preventive of the initial attack upon tissues injured by insects. Finally, upon the theory outlined above, any agency which would tend to check the ravages of the insects would equally limit the spread of the blight. Bordeaux mixture is not usually regarded as of much value as an insecticide, but the careful investigations recently conducted by Jones* prove that Bordeaux mixture acts as a

* Vt. Agr. Exp. Station, Rep. for 1893, p. 50.

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deterrent against flea-beetles, and in this fact a reason may be found for the benefit arising from the use of the mixture in the case of "early blight."

A few sentences from a recent address by Prof. Jones* have a direct bearing upon this subject. "Leaves thus mutilated (by the flea-beetle) are most disastrously exposed to the effects of drought during dry weather, and to the inroads of fungi during wet weather. Indeed these secondary injuries follow so closely after the attacks of the flea-beetle, that the majority of potato growers attribute the entire trouble to these secondary agencies."

We may now consider the second fact in favor of the parasitic nature of "early blight," viz: the susceptibility of potato leaves to inoculation with *Macrosporium* spores, as reported by Chester.

If these experiments are verified, there can be no doubt but that *Macrosporium Solani* is a true parasite capable of attacking sound leaves of the potato and tomato, and inducing in them symptoms of serious disease. Upon this point I will quote a letter received from Prof. Chester, under date of July 27th, 1894: "At the outset I was myself sceptical of *Macrosporium Solani* as the immediate and active cause of the trouble, and I am still inclined to regard the fungus as perhaps a facultative parasite, capable of assuming the role of a (true) parasite only under certain conditions unfavorable to the plant. In my examinations of diseased leaves I have so far always been able to find the *Macrosporium*, although I have quite invariably found the sporophores sparsely distributed and the spores correspondingly few. This has defeated my efforts to get the fungus in artificial cultures. My efforts at inoculation had therefore to be made by placing upon healthy potato leaves, upon plants growing in the glass house, small bits of the diseased leaves, which microscopic examination showed contained the spores of *Macrosporium*. In this way I brought the spores into direct contact with healthy, growing leaves, in the presence of sufficient moisture to favor their germination. Thus I succeeded in the majority of cases in infecting both potato and tomato leaves, causing the black spots which afterwards developed a fruiting of the fungus more abundantly than was the case in nature. Whether the moisture and shading of an area on the growing leaf effected by the bit of dead leaf placed thereon, may not at the outset have etiolated the leaf at this point sufficiently to have given the fungus just

† Agricultural Science, Vol. viii, p. 364.

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the needed advantage, is a question which I did not attempt to answer. However, I felt convinced at the time that the fungus spoken of was either directly or indirectly an agent in the production of the trouble. It is quite possible that the trouble is partly physiological, partly parasitic, and it is furthermore quite possible that the *Macrosporium* in question is a facultative parasite, and not a true parasite as I at first assumed. Until we can get this fungus in pure cultures on artificial media so as to have an abundance of pure material for inoculation, we cannot expect to solve the questions under discussion."

It will be readily seen that these experiments do not furnish absolute proof. Pure cultures were not obtained, and there was therefore no positive proof that the *Macrosporium* was the immediate cause of the trouble induced in the leaves; the leaves themselves were subjected to conditions seldom obtaining out of doors; and the conditions of moisture were far more favorable to fungus growth than those observed in the field when the "early blight" is most severe. In fact the atmospheric conditions coincident with the appearance of "early blight" as thus far observed, are not generally conducive to fungus growth.*

Finally, through the kindness of Prof. Jones, I was enabled to examine a number of specimens of "early blight," and to compare them with specimens obtained by myself. In these specimens a somewhat similar appearance had apparently been caused by two distinct agencies, one of which might possibly be of a physiological nature. The other might as possibly be fungous, since upon many of the leaves examined, the *Macrosporium* was evident under the microscope. Both classes of injury appeared in connection with the marks of the flea-beetle, both were exhibited as brown spots and blotches marked with concentric rings; but in the specimens characterized by the presence of the fungus the spots were more sharply defined and darker in color. This difference was sufficiently marked to enable a close observer to distinguish either one in the field after a little practice, but a comparison between the two produced the impression that both classes of injury might have been originally caused by the same agency, and that the slight difference in appearance might be due to the fact that in the one case a fungus had occupied the injured tissue, and in the other had not done so. To sum up then, the essential points of this theory: It seems possible that the "early

* See additional note on the "early blight" of potatoes, p. 133.

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blight" of potatoes may be due to the physiological effects of extreme heat and dryness acting upon leaf tissues at a distance from the roots, and already injured by predatory insects, especially those abundant under such atmospheric conditions; that anything which will check the ravages of the insects will in a measure check the blight; and that tissues so injured are liable to the attacks of certain fungi which may enhance the injury.

Whatever the value of this theory, the facts in the case warrant certain recommendations regarding the treatment of potatoes.

(1) Cultivate the surface soil to a little depth frequently and thoroughly especially in seasons of extreme heat and drought.

(2) Treat the vines, beginning earlier than usual, with strong Bordeaux mixture (6 lbs. copper sulphate, 4 lbs. lime, 22 galls. water), or with Bordeaux mixture to every 10 galls. of which is added 1 lb. of soap dissolved in hot water; either mixture acts as a deterrent against the flea-beetle.* When the potato-bug appears, add Paris green to the mixture at the rate of ¼ lb. to 50 gallons.

(3) Prof. Jones recommends late planting in order to escape the injuries of "early blight." "Early potatoes form their tubers largely during the dryer weather of July, then, weakened by this effort, they succumb readily to the combined effects of dry weather, insect attacks, and the early-blight fungus." This practice is to be emphasized in case growers are prepared to treat their vines for the late blight or rot, which is especially liable to attack late potatoes.

ADDITIONAL NOTE ON THE "EARLY BLIGHT" OF POTATOES.

Since the above was written there has been published by Prof. Sorauer,† one of the most able vegetable pathologists of Europe, an article which bears so directly upon the subject in hand that I may be pardoned for quoting from it somewhat at length. The article deals with a tendency which the author finds among investigators to attribute true parasitism to many fungi which are found associated with disease, and to conclude from insufficient data that in such cases the fungus is the primary cause of the diseased condition. Such conclusions are usually based upon inoculation experiments, and in this connection Prof. Sorauer writes as follows: "No doubt the greater number of such observations are correct, since as a rule inoculation experiments show that such fungi as those to which our common moulds

* Vt. Agr. Exp. Sta., Rep. for 1893, p. 50.

† Zeitschrift für Pflanzenkrankheiten. Bd. IV, Heft 6, p. 325.

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belong, are able to destroy an organ completely. But this evidence remains incomplete and the designation of such fungi simply as parasites is uncertain and confusing, until experimental proof is obtained that *the fungus is able to induce disease in a sound organ still retaining its normal function upon the organism;* and this proof is rarely forthcoming. I am convinced that we should make greater advances in our knowledge of diseases if we would regard parasites less as exclusive causes of disease, and more as diagnostic means for the recognition of an unhealthy condition. The determination and the study of the parasite is of value as a hint as to the direction in which the organism is functionally weak, and our attempts at remedial treatment will no longer be directed merely locally at the diseased organ, but toward a change in the economy of the organism as a whole. In many instances the observer fails to consider the question whether the infected organ may not already have been brought by separation from the organism or by being kept for some time in a damp atmosphere deficient in light, into an enfeebled condition which is the sole cause of its susceptibility. It is often possible in the inoculation of delicate tissues to induce disease in damp weather merely by closely covering the infected area on a sound leaf not detached from the plant, with a portion of another leaf, while the portion not so covered remains sound. In other cases it may be proved by experiments that two seedlings of the same species, and even two shoots on the same plant behave quite differently toward parasites, if one of them be enfeebled by excess of heat in a greenhouse, while the other is allowed to grow normally in the open air. Recent experiments show that in the case of plants which require water, excessive dryness increases their susceptibility to fungus attack."

Upon these grounds Prof. Sorauer concludes that a distinction should be made between strictly obligate parasitism and cases in which the fungus can gain a foothold only upon an injured surface, and he suggests a separation of parasitic fungi into three classes: (1) absolute parasites, attacking uninjured, healthy organs; (2) partial parasites, attacking uninjured but unhealthy organs; and (3) wound-parasites, attacking injured organs at the point of injury.

The facts elucidated in connection with the fungus associated with "early blight" would seem to justify us in including it in the second or possibly the third class, instead of in the first class as heretofore.

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EXPERIMENTS ON THE TREATMENT OF PEAR-SCAB.

(*Fusicladium pirinum*, (Lib.) Fckl.)

By Wm. C. Sturgis.

The experiments of the past two years in the orchard of Mr. A. E. Plant, of Branford, were continued during the summer of 1894. As in previous years, the experiment was designed mainly to test the value of the winter treatment alone, consisting of a simple solution of copper sulphate at the rate of 1 lb. to 25 galls. of water, as compared with the same treatment enforced by treatment during the summer with Bordeaux mixture. The winter treatment was applied thoroughly on March 31st, before the buds had begun to swell appreciably, and of the trees so treated a portion received no further treatment while the remainder were sprayed with Bordeaux mixture three times, on May 4th and 17th, and June 6th. A third block of trees was reserved as a check and received no treatment of any kind. For convenience of reference we here designate the separate plots and the treatment received by each.

Plot A, received winter treatment only.

Plot B, received winter and summer treatment.

Plot C, received no treatment. (Reserved as a check.)

Plot D, received winter and summer treatment.

Plot E, received summer treatment only.

At the time of harvesting, Mr. Plant made careful notes upon the general appearance of the trees, and the extent to which "scab" prevailed upon both leaves and fruit; the following points are based upon these notes:

In plot A, the fruit was considerably spotted by "scab," especially the Lawrence variety, most of which was unfit for use. The foliage however, was retained well.

In plot B, the fruit was very little affected by the "scab," and the leaves held on well. Regarding this plot Mr. Plant writes: "The plot comprises several Lawrence trees the fruit of which has been in previous years a total loss. If we can overcome the "scab" next year in the same proportion as we did this year, then, if the trees bear, we can sell some fruit." There is no doubt but that a fourth treatment should have been given late in June or early in July. The prolonged drought of June was broken July 22d, and frequent showers ensued accompanied by much warm,

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damp weather. At this time there were but slight traces of the Bordeaux mixture remaining upon the trees from the spraying of June 6th, and the small amount of "scab" upon the trees of plot B developed after the rains began. This might have been prevented altogether by an application during July.

Plot C, which was reserved as a check and received no treatment, showed considerable "scab" on both foliage and fruit, although the trees were all Bartletts, a variety which in this orchard has not been subject to severe attacks of "scab." The leaves began to shed badly in August. In picking the fruit it was very easy to distinguish the dividing line between plots C and D.

Plots D and E showed little difference in the quality of the fruit. The trees were all of the Bartlett variety and yielded a crop of perfect fruit. The leaves also were free from "scab" and were held until frost.

On the whole the conclusion seems a fair one, that the winter treatment of pears for scab hardly warrants the necessary outlay of time and money. As good results are obtained by thorough treatment during the summer only, as when such treatment has been preceded by a single application of copper sulphate in early spring. That the winter treatment is of some value however, is seen from the fact that trees so treated matured a better quality of fruit and retained their foliage better than trees which received no treatment at all.

Mr. Plant's report calls attention incidentally to one or two other points of interest, especially the effect of Bordeaux mixture upon lichens which are liable to infest the bark of pear trees. The experiments of Waite* have indeed already demonstrated the value of Bordeaux mixture in ridding pear trees of lichens; nevertheless it is interesting to note how thoroughly and permanently this result is attained. Not only were the trees which received Bordeaux mixture this season, completely freed from all lichen-growths, but the trees in plot C which were sprayed during the summer of 1893 and thus denuded of lichens, remained completely free from them this year although the trees in this plot were not sprayed. Not only are such growths a disfigurement to the tree, but they would seem to offer peculiar conveniences for the harboring during the winter, of spores which will serve to infest the trees the next spring.

* Journal of Mycology, Vol. vii, No. 3, pp. 264–268, with plates.

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Finally Mr. Plant calls attention to the fact that in the case of currant bushes occupying the spaces between the rows of pear trees in his orchard, those in the neighborhood of the unsprayed trees and which therefore received no Bordeaux mixture, shed their leaves several weeks ahead of time; while those which incidentally received a portion of the spray intended primarily for the pear trees, held their leaves, and, if the mixture contained Paris green, were not affected by currant worms. These facts are worthy of note.

MISCELLANEOUS NOTES ON FUNGI.

By Wm. C. Sturgis.

The following notes upon parasitic fungi and insects are compiled from the results of personal observation in the field and from correspondence received during the past year.

Quince Rust, (*Roestelia aurantiaca*, Pk.). This rust has been abundant upon quinces during the past season. It manifests itself in swollen distortions of the young branches and fruit, the portions affected showing minute pimples which eventually produce a brilliant orange dust, the spores of the fungus. Letters received from various parts of the State indicate a prevailing impression that this disease has some connection with the "fire blight" described in the present report. The impression is a mistaken one; the two diseases are quite distinct as to both cause and effect. It may be well to repeat the fact that this rust as it appears upon quinces is but another form of the fungus common upon red cedars in spring and known as "cedar apples." The form occurring upon quinces is unable immediately to infect other quince trees, but attacks the red cedar, and it is upon the latter that the spores are produced which give rise to the quince rust. As regards treatment, my own experience indicates that the common fungicides are of little avail in preventing the disease, trees which have been sprayed continuously for four years as a protection against leaf spot (*Entomosporium maculatum*), showing rust almost equally with trees not sprayed.

In the case of the orange rust of apples, a disease very nearly related to quince rust, the successful use of Bordeaux mixture has been reported,* but as a rule it would seem more advisable to cut out and burn the diseased portions (especially in view of the

* U. S. Dept. Agr., Sec. of Veg. Path., Bull. 11, p. 46, 1890.

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opinion held by many that the fungus is perennial in the tissues attacked), and to eradicate neighboring red cedars.

Scab and Mould of Peaches. (*Cladosporium carpophilum*, Thm.,) and (*Oidium fructigenum*, Kze. & Schm.) These two fungi attack plums and cherries as well as peaches. The mould, producing a grayish, powdery coating upon the fruit, and inducing rapid decay, is too well known to require any extended description.

The scab seems to have received but little recognition, yet it undoubtedly has been the cause of widespread injury to the peach crop. It may make its appearance upon the fruit at any time during the growing season, appearing first as small, circular, greenish spots, which increase in size, become darker and of a brownish color, and in severe cases may spread over the greater part of the surface of the fruit, preventing the normal expansion of the skin, retarding the ripening and mellowing of the flesh, and eventually producing deep cracks in the fruit. The fungus does not induce decay, but it renders the fruit unsightly and prevents an even ripening, thus considerably reducing its market value.

So far as I know, no definite experiments have been as yet undertaken with a view of testing the value of fungicides in preventing this disease of peaches. Bordeaux mixture has been recommended for the treatment of the disease as it affects plums and cherries;* but the peach, as shown by Arthur,† is less susceptible to successful treatment. The foliage is of great delicacy, and liable to injury from fungicides; and the downy character of the surface of the fruit prevents the fungicide from reaching the fungus thoroughly, since the latter grows upon the skin itself and is in a measure protected by the fruit hairs. Possibly early applications of weak Bordeaux mixture, containing no more than six pounds of copper sulphate and four pounds of lime to fifty gallons of water would serve to prevent the initial attack of the fungus without injury to the foliage. Experiments in this direction will be attempted during the coming season.

As regards the peach mould, the experiments of Chester‡ prove conclusively that the trouble can be largely prevented by the use of copper carbonate in suspension (1 lb. copper carbonate in 25 galls. water), the ammonia solution of copper carbonate (5 oz.

* Iowa Agr. Coll. Exp. Sta., Bull. 23, p. 920, 1894.

† Ind. Agr. Exp. Sta , Bull. 19, pp. 5–8, 1889.

‡ Del. Agr. Exp. Sta., Bull. xix, 1892.

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copper carbonate, 3 pts. strong ammonia, 45 galls. water), or Bordeaux mixture. He recommends that copper sulphate in the proportion of one pound to twenty-five gallons of water be applied before the fruit buds begin to swell in early spring; that as soon as the fruit buds begin to swell either one of the fungicides above mentioned be applied, and again just before the buds open. A third application should be made as soon as the fruit shows signs of color, and two or three more at intervals of a week during the period of ripening. Whatever method of treatment be adopted, it must be borne in mind that the source of infection in this case, and probably in that of the scab, lies in the diseased fruit of the previous year. Too much stress therefore cannot be laid upon the necessity of gathering and burning all such fruit.

SOME INJURIOUS INSECTS.

By Wm. C. Sturgis.

The Onion Maggot (*Anthomyia ceparum*). Frequent complaints have been received regarding this pest, and a few notes upon the subject may prove of value. The adult insect, a small two-winged fly, deposits its eggs on the lower portion of the young onion plants during the months of April and May. In about a week the eggs give rise to small, whitish grubs or maggots which eat their way into the bulb upon which they feed for about two weeks. They then leave the bulb, enter the ground, and change to the pupa-condition, from which, in course of time, the adult flies emerge. Occasionally the maggots remain in the bulb and the brown pupæ are found in the stored onions. Several broods are produced during the summer.

Various methods of destroying this pest have been recommended. Ormerod* suggests rotation with some other crop in order that the flies emerging from the pupæ which remain in the soil, may not find onion plants at hand upon which to deposit their eggs; earthing the young plants well up above the collar so that the flies are prevented from reaching the bulb; pulling and destroying the plants first affected, by which means the migration of the maggots to sound bulbs is checked; the avoidance as far as possible of natural manures, in which the larvæ of these insects

* A Text book of Agricultural Entomology, pp. 49–56, 1892.

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live; or finally the application of lime to the land. E. O. Orpet* recommends the following method which is well worth a trial. "Half a pint of kerosene is well mixed with a pailful of some dry material, preferably wood ashes, but sand, sawdust, or even dry soil will do fairly well; after the plants are well up and the trouble is at hand, a sprinkling of this mixture along the rows about twice a week during the time the fly does its work, will be found a sure prevention of the trouble. After the end of May there is little danger, as the onions are of a good size and not so liable to injury."

The Fir Mite. Early in June specimens of fir-branches (*Abies balsamia*) were received from West Cornwall, showing a peculiar curling of the young leaves at the extremities of the branches. Careful examination revealed the presence of numbers of small mites, insects belonging to the Spider Family, and related to the "red spider" commonly found upon greenhouse plants. These mites were of a dark brownish color, rather lighter beneath, and were undoubtedly the cause of the trouble. The leaves attacked were curled and twisted, showing the silvery lower surface, and in many cases were of a pale yellowish color, Plate VIII. In the axils of the leaves were to be seen the delicate webs spun by the mites. The appearance of the twigs indicated that these insects might very seriously interfere with the development of the new growth. The only reference which I have found to this subject is contained in a short note on p. 869 of the Fifth Report of the Entomological Commission of the U. S. Dept. of Agriculture, (1890). The insect is described and its effect upon the leaves is figured, but no suggestions are given as to remedial treatment.

If we may judge from analogy with what we know of the "red spider," and from the atmospheric conditions prevailing during its period of attack the past summer, we may conclude that this mite flourishes during extremely dry weather, and that in a comparatively damp season or locality there is but little fear of serious injury. In nurseries or plantations of small trees, where the tips are readily accessible, keeping the tips wet with water during very dry weather, or spraying them with a decoction of tobacco, would probably rid them of this pest.

Lice of apple and cherry trees. Much injury is caused every year to the young foliage of the apple and cherry by two species of lice, *Aphis Mali*, and *Myzus Cerasi*. The former, infesting

* Garden and Forest, Vol. vii, p. 187, 1894.

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apple trees, is green; the latter, upon cherry, is black and shining. They often occur in enormous numbers, covering the lower surface of the leaves and causing them to become curled and dwarfed. The life-history of these insects is not yet fully known. In the spring the eggs which have been laid upon the twigs the previous autumn, hatch into young lice which quickly infest the leaves and suck out the juices. In ten days or less they are mature and begin producing young, thus increasing with great rapidity. Early in July they migrate from the apple and cherry to some other plant. (Webster states* in regard to the apple lice, that they migrate to wheat and other grasses). In the late summer or early autumn they return to the apple and cherry trees as winged females which at once produce a brood of wingless, egg-laying females. With the laying of these eggs the life-history is completed. If it were known definitely to what plants these lice migrated in the summer, we could the more readily suggest a remedy. As it is, kerosene emulsion or strong soapsuds seem to be the most practical substances for destroying the insects. Wherever it is possible the entire twig infested should be bent over and dipped thoroughly in the mixture; when this method is impracticable, spraying the trees frequently must be resorted to, although many of the lice will escape owing to the fact that they are protected within the curled leaves. The following modification of the kerosene emulsion has been suggested, and would seem to be more fatal to insects than the usual formula.

(1) To 3 quarts of kerosene add 1½ pounds of pyrethrum powder, and let it stand four days in a close vessel. (2) Dissolve 10 ounces of common hard soap in 2½ quarts of boiling water. Strain off 2½ quarts of (1) and add it to (2) while the latter is still hot. Churn for five minutes through a force pump until the mixture is creamy. For use, dilute with 150 parts of cold water. The undiluted mixture may be kept indefinitely in glass fruit jars or other vessels, if thoroughly closed.

The Peach curculio (*Conotrachelus nenuphar*). This is the same insect which commonly attacks plums, cherries, and apples. It has not been reported as common in this State upon peaches, but from my own observations in a number of orchards I am convinced that it is far more common than is supposed and that it is to blame for much injury at present attributed to other causes. The curculio attacks the young fruit almost as soon as the petals

* Ohio Agr. Exp. Sta., 12th Ann. Rept., p. xxxv, 1894.

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have fallen, cutting the well known crescent-like flap beneath which the egg is deposited. The fruit so injured is liable to fall prematurely, and if it remain upon the tree the injury soon becomes apparent from the gummy exudation oozing from the wound. Many growers are accustomed to shake the insects from the trees on to a white cloth, by means of a sudden jar, and this is perhaps the best method of destroying them; but it would seem that a very weak mixture of Paris green in water would kill the insects without injuring even the delicate foliage of the peach. A safe formula would be 4 ounces of Paris green in 45 gallons of water, to which are added 2 pounds of fresh lime slacked in 5 gallons of water. As in the case of Bordeaux mixture and Paris green, the lime tends to neutralize the caustic action of the arsenite.

The Peach bark beetle (*Scolytus rugulosus*, Ratz.). Late in September last, portions of the bark of a peach tree were sent to the Station from Cheshire, completely riddled with minute holes the size of a pin head. With the bark were specimens of a small, black beetle to which the injury was attributed. There was little difficulty in referring the insect to the species above named, a species originally imported from Europe, but now, on Bailey's authority, "widely distributed in eastern America."* The same writer states that it attacks the plum, apricot, cherry, pear, apple, quince, and some ornamental trees.

At present it is not sufficiently common in Connecticut to cause any serious apprehension, nor does it seem to attack trees which are otherwise thrifty and well cared for. Should it become a pest it could probably be held in check by applying to the bark some poisonous substance containing either Paris green, kerosene, or carbolic acid. Bailey suggests that all seriously affected branches and trees should be burned.

For fuller information upon this subject reference may be had to the investigations of Forbes published in Bull. 15 of the Ill. Agr. Exp. Station (1891).

* Cornell Univ. Agr. Exp. Sta., Bull. 74, p. 378, 1894.

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NOTES ON SOME LEAF MINERS.

By W. E. Britton.

During the season of 1894, plants of several different species on and about the Station grounds were attacked by "leaf miners." Though of no great economic importance at present these insects essentially injure the plants which they attack.

The term "leaf miner" is applied to those insects which feed upon the soft interior part of the leaf just below the epidermis, and between the upper and under layers of epidermal cells which form the two surfaces of the leaf. This injury is done while the insect is in the larval or grub stage, that being the period of growth.

The egg is usually deposited just beneath the epidermis, and the larva as soon as hatched feeds upon the soft parenchymatous tissue surrounding it.

The leaf miners observed by the writer belong to two different zoölogical orders, (1) Diptera, or two-winged flies, and (2) Lepidoptera, the order including moths and butterflies.

Those here noticed belong to the Diptera. We have found a different species of insect upon each species of plant attacked, and in some cases two distinctly different insects upon the same plant. The leaves of the apple, pear, quince, grape, columbine and corn, growing upon the Station grounds, have been attacked by leaf miners during the past season, though it was only on the columbine and corn that the insects were made notably conspicuous by their attacks.

Corn Leaf Miner (*Odontocera dorsalis*, Loew).

This insect attacked the corn which was grown under glass in the vegetation experiment referred to in a previous article, page 73 of this Report. It was first noticed about July 1st when it began its operations as a miner. The adult pierces the tip of the leaf, and deposits an egg beneath the epidermis, and the larva as soon as hatched, begins tunneling between the two epidermal surfaces. The larva usually travels toward the base of the leaf, sometimes along the midrib, sometimes near the edge, and often in a crooked or zigzag path. The tunnel is very narrow, a mere line at first, but it gradually increases in width as the larva grows, and so is broadest at the end farthest from the starting point.

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The tunnels vary in size and length. One was nearly straight, and measured 19½ inches in length, and ⅛ of an inch wide at the broadest part. This, however, was an extremely large one, and the dimensions of the majority were less.

The tunnel usually begins near the tip of the leaf, though not always. Sometimes several larvæ are at work in the same leaf, with tracks parallel or crossing each other. The track usually shows more distinctly from the upper side of the leaf, but can generally be seen from either side. See Plate X. It is rendered nearly white and semi-transparent by the removal of the green coloring matter of the leaf.

In the enlarged end of this tunnel the larva may be found during its feeding stage. When it becomes full-grown, it retreats an inch or two in the tunnel and enters the pupa stage which is passed inside the leaf. Like all dipterous larvæ the skin hardens, and becomes the covering of the puparium.

After a short time it emerges from its prison, punctures the skin of the corn leaf, and escapes, a small two-winged fly.

The larva is a footless grub, about ⅛ of an inch in length when full-grown. It is pale yellow in color, and almost transparent. On entering the pupa state it becomes considerably darker in color, and shrinks slightly.

The adult is a small fly. Its head, thorax, and abdomen are nearly black, slightly marked with light brown or yellow. The wings are colorless, legs yellow, and the insect is covered with hairs.

Specimens sent to L. O. Howard, Entomologist of the Department of Agriculture at Washington, and submitted by him for determination to his assistant, Mr. D. W. Coquillett, a specialist in the order Diptera, were pronounced to be *Odontocera dorsalis*, Loew, of the family Agromyzidæ, an insect with habits hitherto unknown. The insect in its different stages of development is shown in Plate XI, prepared from original drawings.

a. Adult fly. *b.* Young larva. *c.* Pupa, all greatly enlarged.

Only a few leaves of the corn growing in the Station garden were attacked by this leaf miner, but the lower leaves of nearly every corn plant in the greenhouse were more or less tunneled by the larvæ. It is not probable that it will ever become a serious enemy to the field crop. If it should, however, it would be a difficult pest to fight, for the larva being inside the leaf cannot be reached by spraying. The only way to destroy them is to

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PLATE X. Corn Leaf injured by Leaf Miner, *Odontocera Dorsalis.*

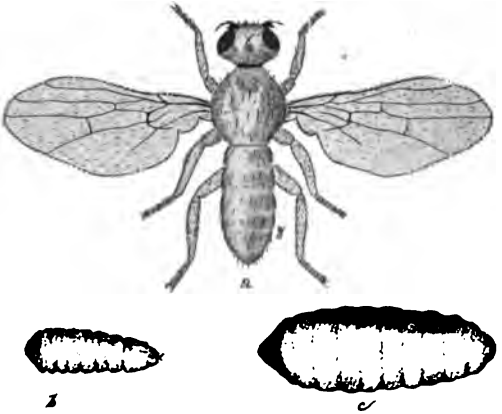

PLATE XI. Leaf Miner. *Odontocera Dorsalis.*

PLATE XII. Columbine Leaves injured by Leaf Miner, *Phytomyza Aquilegiæ.*

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examine the affected leaves for each individual, which will be found near the enlarged extremity of the tunnel, where it may be destroyed by a knife or needle. Of course this method would be utterly impracticable in farm practice. Natural enemies will doubtless keep this leaf miner in check.

Hymenopterous insects came from two of the pupæ which were gathered. These both belonged to the same species which is evidently parasitic upon *Odontocera dorsalis*. This parasitic insect is stated by Mr. Howard to be a new species of *Sphegigaster*.

Columbine Leaf Miner (*Phytomyza aquilegiæ.*)

Several species of Aquilegia (Columbine) growing about the Station grounds were severely attacked by a small fly, which deposits its egg either on or inside the leaf. The larva as soon as hatched, begins to tunnel in the soft parenchymatous tissue of the leaf just beneath the epidermis.

My attention was first called to the injury June 26th, and from that time continuously until frost came, the leaves showed indications of the presence of the leaf miner. This signifies that there are several broods each year.

Some young seedlings of *A. Canadensis* were severely injured, and old plants of other species lost nearly all their leaves from the effects of its attack. The soft part was entirely eaten out in some cases, and nothing left but the skeleton or framework of the leaf.

The full-grown larva is a footless grub one-sixteenth of an inch in length. It emerges from its mine to pupate, and fastens itself to the underside of the leaf, eight or ten being often found hanging from the under surface of a single leaf.

The covering, during this stage of the insect's transformations, is formed by the hardening of the skin which the larva casts but does not vacate. It turns to a dark brown color, and shrinks slightly in length, the thickness remaining about the same. Finally the end of the covering is ruptured, and the adult comes forth a small two-winged fly. One specimen was found pupating in the mine of the leaf, but this does not appear to be the usual habit.

Adults were reared from the mines of the leaf, and sent to the U. S. Department of Agriculture for identification. Dr. C. L. Marlatt, Acting Entomologist, replied as follows: "Mr. D. W.

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Coquillett reports that there are two distinct species of *Phytomyza*, the larvæ of which mine the leaves of Columbine in Europe, viz: *P. ancholiæ*, Desvoidy, an account of which is given in the Annales de la Soc. Entom. de France, 2d series, Vol. x, p. 153; and *P. aquilegiæ*, Hardy, described in the Annals and Magazine of Natural History, 2d series, Vol. iv, p. 392. Your species agrees so well with the last named that there is scarcely any doubt in so referring it, although it has not hitherto been reported as occurring in this country."

Plate XII shows leaves of *Aquilegia Canadensis* injured by larvæ of *Phytomyza aquilegiæ*.

No remedy has yet been suggested except to pick and destroy the infested leaves. If this leaf miner has no parasite to keep it in check, it will soon become so troublesome as to greatly diminish the use of the Columbine as a hardy flowering perennial.

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THE PROTEIDS OF THE RYE KERNEL.

By Thomas B. Osborne.

The proteids of this seed have been but little studied and the statements published leave the subject in much confusion.

Einhof, who in 1805* undertook an analysis of rye, was the first to make observations on the proteids obtained therefrom. He found that an aqueous extract of rye meal contained two distinct proteid substances, one coagulating on boiling, and insoluble in alcohol, which he called albumin, and the other not coagulating, but soluble in alcohol, which he called gluten [kleber]. The latter he considered to be identical with the similar substance extracted from wheat gluten by alcohol. Treatment with alcohol yielded much more "kleber" than was extracted by water alone. It is interesting to note that Einhof in this investigation first discovered that characteristic differences exist between different kinds of vegetable proteid matter, it being thought at that time that gluten and albumin were simply modifications of the same body which under like conditions would show the same properties.

Heldt† in 1843 published a description of the proteid taken up by alcohol from rye meal. He prepared it by extracting the meal with hot alcohol, distilling off the alcohol and treating the residue with ether to remove fat, and with water to remove ether and sugar.

This preparation was analyzed with the following result:

Carbon	56.38
Hydrogen	7.87
Nitrogen	15.83
Sulphur, Oxygen	19.92
	100.00

Heldt remarked, "the same composition was found by Scherer and Jones for other nitrogenous constituents of plants, plant-casein, plant-albumin and plant-gelatin, to which last this body appears to stand nearest."

* Jour. d. Chem. v. Gehlen, V, 131.

† Ann. d. Chem. u. Phar., XLV, 195.

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Jones* obtained albumin from rye by boiling the aqueous extract and treating the resulting coagulum with ether. He states that this albumin contained:

Carbon	54.74
Hydrogen	7.77
Nitrogen	15.85
Oxygen	21.64
	100.00

Verdeil,† contrary to the experience of Einhof, von Bibra, Ritthausen and the writer obtained gluten from rye meal by kneading and washing in a cloth until starch was removed. He states that there remained a tough, glutinous substance which could be easily drawn into threads. This gluten he says was not pure but was contaminated with a substance soluble in alcohol. When thoroughly extracted with alcohol he considered it to be pure. He determined sulphur in the gluten and found 0.989 and 0.972 per cent. Von Bibra‡ considered the proteid extracted from rye by alcohol to be the same as that similarly obtained from wheat. He gave the nitrogen content of this body as 15.73, 15.52 and 15.50 and the sulphur as 0.973 and 0.950 per cent. He also recognized the presence of "casein" which he did not analyze, and found from 1.565 to 2.799 per cent. of albumin which contained 15.53 and 15.42 per cent. of nitrogen. He considered the proteids of rye to be same as those of wheat.

Ritthausen§ described three proteid substances which he found in rye, albumin, soluble in water, mucedin, soluble in alcohol, and gluten-casein, soluble in dilute potash water but insoluble in water and cold alcohol.

Albumin, he says, is present in the aqueous extracts but he made no further examination of this body. The mucedin he considers to be the only proteid, soluble in alcohol, present in the rye kernel and this he regarded as similar to the mucedin which was believed to exist in the wheat kernel. He was unable to detect the presence of gliadin. Mucedin was prepared by extracting the meal with hot alcohol of 85 per cent. and concentrating and cooling the solution. The deposited substance was further

* Ann. d. Chem. u. Phar., XL, 66.

† Ann. d. Chem. u. Pharm., LVIII, 319.

‡ Die Getreidearten u. das Brod, Nuernberg, 1860, 291.

§ Jour. f. prakt. Chem., XCIX, 439, and Die Eiweisskoerper, etc., Bonn, 1872, p. 83.

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extracted with alcohol and ether. It was then dissolved in acetic acid and fractionally precipitated with potash. He states the composition of the substance as:

Carbon	53.61
Hydrogen	6.79
Nitrogen	16.84
Sulphur	0.50
Oxygen	22.26
	100.00

The gluten-casein was obtained by extracting the rye meal directly with very dilute potash-water, precipitating with acetic acid and washing with water, alcohol and ether. Two preparations were made and gave as an average the following figures on analysis:

Carbon	52.14
Hydrogen	6.93
Nitrogen	16.38
Sulphur	1.06
Oxygen	23.49
	100.00

Sidney Martin* states that wheat, rye and barley contain a globulin substance similar in properties to animal myosin, being soluble in 10–15 per cent. sodium chloride solutions, precipitated therefrom by saturation with sodium chloride and with magnesium sulphate and coagulating at 55° to 60°. This globulin is precipitated by dialysis and thereby is converted into the albuminate form. It is very evident from the foregoing summary of previous work that we have no satisfactory knowledge of the rye-proteids.

In presenting the results of my investigation the subject may be most conveniently discussed under the following heads:

A, proteids soluble in water, B, proteids insoluble in water but soluble in saline solutions, C, proteids insoluble in water and in saline solutions and soluble in alcohol, and, D, proteid insoluble in water, saline solutions, or alcohol but soluble in dilute alkalies.

A, Proteids soluble in Water. Leucosin. Proteose.

The proteids soluble in water are best examined in extracts made in the first instance with 10 per cent. sodium chloride solution from which subsequently the soluble salts have been removed

* Jour. Physiol., VIII, viii.

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by prolonged dialysis. When water is applied to the grain it becomes a weak saline solution which not only takes up globulins but also extracts gliadin whose presence greatly complicates the examination of the water soluble proteids. Rye meal* was accordingly exhausted with a solution containing 10-per cent. sodium chloride and the extract, after syphoning from the subsided insoluble matters, was freed from salts and globulin by dialysis in river water and filtration. The resulting solution yielded no more globulin by dialysis in distilled water and contained only those proteids extracted from the seed which were soluble in pure water. As the extract was bulky the proteids were precipitated by saturation with ammonium sulphate and thereupon dissolved in water. A comparatively concentrated solution was thus obtained which was very nearly freed from ammonium sulphate by dialysis. It then had the following properties. When heated slowly it became turbid at 52° and particulate at 63°. After filtering from this coagulum nothing more separated even on boiling. Saturation of the dialyzed solution with sodium chloride gave a precipitate that dissolved readily in water to a solution, which, heated to 63°, yielded a coagulum of albumin. The filtrate from this coagulum was again saturated with salt and a considerable precipitate obtained showing that with the albumin some proteose-like body was thrown down. Nitric acid added to the solution of this precipitate in water gave a precipitate which dissolved on warming and reappeared on cooling. The solution after filtering out the first precipitate of proteose and albumin, produced by saturation with sodium chloride, gave more precipitate on adding acetic acid, showing the presence of a further quantity of proteose. The coagulum above described, which separated on heating its solution to 65°, was washed thoroughly with water, alcohol, absolute alcohol and ether and dried over sulphuric acid. When dried at 110° it had the following composition:

COAGULATED RYE ALBUMIN, LEUCOSIN, *Preparation* 1.

	I.	II.	Average.	Ash-free.
Carbon	52.31	....	52.31	52.57
Hydrogen	6.78	....	6.78	6.81
Nitrogen	16.14	16.11	16.13	16.22
Sulphur } Oxygen }	....	....	....	24.40
				100.00
Ash	0.51			

* The rye meal used throughout this work was obtained by grinding, in the laboratory, portions of clean and fresh winter rye, as needed for each extraction.

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Another extract was examined in a slightly different way. 1000 grams of rye meal were extracted with 11 liters of 10 per cent. sodium chloride solution and, in order to get rid of the large amount of gum taken up, the solution, after filtering, was dialyzed and then saturated with ammonium sulphate. The precipitate thus produced was dissolved, as far as possible in 10-per cent. sodium chloride brine, filtered clear and dialyzed until chlorides were removed. The solution after filtering clear was then heated to 65° and the albumin that separated was filtered out, washed thoroughly with hot water, with alcohol and with ether and dried over sulphuric acid. This preparation, 2, weighed 1.21 grams and had the following composition:

COAGULATED RYE ALBUMIN, LEUCOSIN, *Preparation* 2.

		Ash-free.
Carbon	53.04	53.29
Hydrogen	6.70	6.74
Nitrogen	16.57	16.65
Sulphur } Oxygen }	----	23.32
		100.00
Ash	0.50	

The solution containing the proteoses, filtered from preparation 2, was then treated with 20 per cent. of its weight of dry sodium chloride and a little two-tenths per cent. hydrochloric acid was added which gave a considerable precipitate. This was filtered out, dissolved in distilled water and the solution dialyzed till free from chlorides. This solution then gave a precipitate with nitric acid, which dissolved on warming and precipitated again on cooling. The solution concentrated to a syrup on a water bath was precipitated by pouring into absolute alcohol. The precipitate when dried over sulphuric acid weighed 0.41 gram or one-third as much as the albumin. The filtrate, from the precipitation of this substance [with 20 per cent. of sodium chloride and acid], was saturated with ammonium sulphate and the precipitate thus produced filtered out and dissolved in distilled water. With copper sulphate and potash this substance gave a clear pink color. Its solution gave no precipitate on adding nitric acid until it had been saturated with sodium chloride, when a slight precipitate fell. It yielded no precipitate with copper sulphate. These reactions indicate that besides albumin the aqueous extract contains small quantities of proto- and deutero-proteose.

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Again, 2000 grams of rye meal were treated with 10-per cent. sodium chloride solution and the extract filtered and saturated with ammonium sulphate. The precipitate produced was dissolved in 10-per cent. sodium chloride solution, filtered and dialyzed until all chlorides were removed. After filtering clear the solution was heated to 65° for some time and the coagulum filtered out, washed with hot water, alcohol and ether and dried for analysis, preparation **3.** The filtrate from **3,** was then concentrated by boiling, during which a coagulum developed. This was filtered out, washed as usual and dried for analysis, preparation **4.**

COAGULATED RYE ALBUMIN, LEUCOSIN, *Preparation* **3.**

	I.	II.	Average.	Ash-free.
Carbon	53.41	53.32	53.37	53.52
Hydrogen	6.90	6.82	6.86	6.88
Nitrogen	16.73	....	16.73	16.78
Sulphur, Oxygen	....	....	....	22.82
				100.00
Ash	0.30			

COAGULATED RYE ALBUMIN, LEUCOSIN, *Preparation* **4.**

	I.	II.	Average.	Ash-free.
Carbon	52.64	52.53	52.58	52.86
Hydrogen	6.76	6.73	6.75	6.79
Nitrogen	16.86	....	16.86	16.95
Sulphur, Oxygen	....	....	....	23.40
				100.00
Ash	0.56			

Another extract was made by treating 1700 grams of rye meal with 16 liters of water. After standing over night the solution was filtered off and saturated with ammonium sulphate. The meal residue was treated again in the same way and the filtered extract, after saturating with ammonium sulphate, was added to that first obtained. The precipitated proteids were then dissolved in water yielding a very gummy solution. As this solution was bulky the proteids were again precipitated with ammonium sulphate and the precipitate after filtering out was treated with 3 liters of 10-per cent. sodium chloride solution. The whole was then dialyzed, it having been found that these viscid solutions lost their gummy character on dialysis. After 8 days all the gum had disappeared. The solution was then readily filtered clear. In order to reduce the volume of the solution it was again

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saturated with ammonium sulphate and the large precipitate treated with about a liter of 10-per cent. sodium chloride solution. A turbid liquid resulted which was not cleared by passing through filter paper but on standing became clear and the sediment was found to consist of gliadin, which is to be noticed later. Gliadin is soluble to a considerable extent in pure water and in water containing but a very small amount of dissolved salts, but the addition of a little sodium chloride to its solution precipitates it completely. After the solution had entirely cleared by subsidence it was dialyzed free from chlorides and heated to 65°. The resulting coagulum was then filtered out, washed and dried in the usual manner and found to weigh 1.55 gram. The composition of this preparation was as follows:

COAGULATED RYE ALBUMIN, LEUCOSIN, *Preparation* 5.

		Ash-free.
Carbon	52.67	52.91
Hydrogen	6.78	6.81
Nitrogen	16.57	16.65
Sulphur	1.40	1.40
Oxygen	....	22.23
		100.00
Ash	0.47	

The meal residue, from the water extract that yielded 5, was then treated with 10-per cent. sodium chloride solution and the filtered extract saturated with ammonium sulphate, the precipitate so obtained was filtered out, dissolved in water and sodium chloride solution and dialyzed till free from chlorides. The liquid was then filtered clear and heated to 65°. The coagulum washed and dried weighed 1.92 grams, being therefore considerably greater than the preparation obtained from the aqueous extract. It would appear therefore probable that the albumin forms a constituent of the aleurone grains which may not be broken up until treated with saline solutions. The following figures show the composition of this preparation:

COAGULATED RYE ALBUMIN, LEUCOSIN, *Preparation* 6.

		Ash-free.
Carbon	52.55	52.77
Hydrogen	6.67	6.70
Nitrogen	16.61	16.68
Sulphur	1.29	1.29
Oxygen	....	22.56
		100.00
Ash	0.42	

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SUMMARY OF ANALYSES OF COAGULATED RYE ALBUMIN, LEUCOSIN.

	1.	2.	3.	4.	5.	6.	Average.
Carbon	52.57	53.29	53.52	52.86	52.91	52.77	52.97
Hydrogen	6.81	6.74	6.88	6.79	6.81	6.70	6.79
Nitrogen	16.22	16.65	16 78	16.95	16.65	16.68	16.66
Sulphur	24.40	23.32	22.82	23.40	1.40	1.29	1.35
Oxygen					22.23	22.56	22.23
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Five hundred grams of rye flour* were extracted with 2000 c. c. of 5-per cent. sodium chloride solution and 1000 c. c. of the clear filtered extract were dialyzed till free from chlorides. The solution was then filtered and heated for 24 hours in a water bath of 70°. The coagulated albumin was filtered out, washed with water, alcohol and ether, and dried over sulphuric acid, and found to weigh 1.08 grams, equivalent to 0.43 per cent. of the flour.

So far as tested this albumin agrees in all respects with that obtained from wheat.† The variations in composition of these preparations are considerable but perhaps not greater than might be expected.

The aqueous and saline extracts of the rye meal contain much gum and coloring matters which render the isolation of pure proteids very difficult. It will be seen, however, that the preparations of wheat albumin and rye albumin have very nearly the same average composition and that both proteids show the same reactions and coagulate at the same temperature. They are unquestionably the same substance, for which I have adopted the name *leucosin*.

COAGULATED LEUCOSIN.

	Wheat. Av. of 5 analyses.	Rye. Av. of 6 analyses.
Carbon	53.02	52.97
Hydrogen	6.84	6.79
Nitrogen	16.80	16.66
Sulphur	1.28	1.35
Oxygen	22.06	22.23
	100.00	100.00

The proteoses of the rye also show the same reactions as those of the wheat kernel, and so far as it is possible to determine they are identical.

* Made by the Health Food Company of New York.

† Am. Chem. Jour., XV, p. 408; also Ann. Report of this Station for 1893, p. 179.

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B. PROTEID SOLUBLE IN SALINE SOLUTIONS. EDESTIN.

Owing to the large amount of gum extracted from the rye meal, the preparation of the globulin in a pure state was found to be extremely difficult. Such preparations as were made disagreed in composition and in only one case was a substance obtained which appeared to be pure enough to warrant the publication of its analysis. So far as could be detected the globulin which separated on dialysis had the same properties as that similarly derived from wheat. One preparation of this globulin, which had nearly the same composition as the wheat globulin and appeared to be free from gum and other impurities, was obtained as follows:—5000 grams of rye flour, made by the Health Food Co. of New York, were extracted with 15 liters of 5-per cent. sodium chloride solution and the extract filtered clear. 9 liters of extract were thus obtained, being approximately equal to a complete extraction of 3 kilos of rye flour.

The entire solution was dialyzed for four days in order to remove the greater part of the gum. The extract was saturated with ammonium sulphate, the precipitate filtered out, suspended in water and dialyzed for three days. Most of the substance was now dissolved and the insoluble matter was filtered out, washed with sodium chloride solution and the filtrate and washings returned to the dialyzer. When free from chlorides the solution was filtered from a small precipitate and this latter washed with water, alcohol and ether and dried over sulphuric acid. Only 1.21 grams of globulin were obtained, which when dried at 110° had the following composition:

RYE GLOBULIN, EDESTIN, *Preparation* 7.		WHEAT GLOBULIN, EDESTIN.	
		Ash-free.	Av. of 5 analyses.
Carbon	51.03	51.19	51.03
Hydrogen	6.72	6.74	6.85
Nitrogen	18.14	18.19	18.39
Sulphur	----	23.88	0.69
Oxygen	----		23.04
Ash	0.33		
		100.00	100.00

The writer has no doubt that this globulin is identical with the *edestin* found in the wheat kernel and other seeds,* but owing to the difficulties encountered in preparing it from rye, further evidence on this point was not obtained.

* Annual Report of this Station for 1893, pp. 179 and 216.

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With reference to Martin's statement concerning the presence of myosin—what is written on that point in the paper by Osborne and Voorhees on the Proteids of the Wheat Kernel applies equally to rye.*

C. PROTEID SOLUBLE IN ALCOHOL. GLIADIN.

After extraction with sodium chloride solution, alcohol of 75 to 80 per cent. takes up a considerable quantity of proteid. 100 grams of rye meal were extracted thoroughly with 10-per cent. sodium chloride solution and then with 75-per cent. alcohol. The alcoholic extract was evaporated to very small volume and the separated proteid washed with water and ether and then dried. It weighed 3.93 grams, being therefore nearly 4. per cent. of the meal. 2000 grams of rye meal were then extracted with alcohol of 0.9 specific gravity, four successive times. Each extract, after filtering clear, was concentrated by distillation on a water bath. The first three extracts yielded on cooling a deposit of proteid but the fourth contained almost none. Each residue was then washed with water and dissolved in 75-per cent. alcohol. The substance from the first extract yielded an insoluble residue which when washed with dilute alcohol, absolute alcohol and ether, gave preparation **8.** This dried at 110° contained 17.00 per cent. of nitrogen. The solutions of the substances from the three extracts in dilute alcohol, were concentrated to about one-fourth their original volume and cooled, when the dissolved proteid separated. The substance from the first extract was digested with absolute alcohol which dissolved a part of it, then with ether and dried, giving preparation **9.** The residue from the second extract was washed superficially with water and then treated in a divided state with distilled water until dissolved. A little saturated sodium chloride solution was then added and the proteid wholly precipitated. The precipitate was then thoroughly dehydrated with absolute alcohol, digested with ether, and dried. This formed preparation **10.** The proteid separated from the third extract was digested with absolute alcohol and with ether, and yielded a small quantity of proteid, preparation **11,** which when dried contained, ash-free, 16.89 per cent. of nitrogen. The absolute alcohol used in dehydrating preparation **9,** with help of the water which it extracted, dissolved a considerable quantity of proteid. This was precipitated by adding a few drops

* Am. Chem. Jour., XV, p. 415.

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of sodium chloride solution. The precipitate produced was then digested with absolute alcohol and ether and when dried was found to contain, ash-free, 16.02 per cent. of nitrogen. The preparation was therefore redissolved in dilute alcohol, filtered perfectly clear, concentrated to small volume and cooled. The proteid separating was then treated as before with absolute alcohol and ether and yielded preparation **12.** The proteid thus extracted showed in all respects the properties of wheat gliadin, and it will be seen that it has nearly the same composition.

RYE GLIADIN, *Preparation* **9.**

	I.	II.	Average.	Ash-free.
Carbon	52.76	----	52.76	52.84
Hydrogen	6.81	----	6.81	6.82
Nitrogen	17.14	17.23	17.19	17.22
Sulphur, Oxygen	----	----	----	23.12
Ash	0.16			100.00

RYE GLIADIN, *Preparation* **10.**

	I.	II.	Average.	Ash-free.
Carbon	53.06	52.90	52.98	53.23
Hydrogen	6.83	7.11	6.97	7.00
Nitrogen	17.13	17.17	17.15	17.23
Sulphur, Oxygen	----	----	----	22.54
Ash	0.48			100.00

RYE GLIADIN, *Preparation* **12.**

	I.	II.	Average.	Ash-free.
Carbon	52.99	53.11	53.05	53.11
Hydrogen	6.73	6.83	6.78	6.79
Nitrogen	17.57	----	17.57	17.59
Sulphur	1.44	----	1.44	1.44
Oxygen	----	----	----	21.07
				100.00
Ash	0.12			

1000 grams of rye meal were thoroughly extracted with 10-per cent. sodium chloride solution and drained as dry as possible on filters. The extracted residue was then treated with alcohol of 0.860 specific gravity four consecutive times. The four red-brown extracts were filtered clear, concentrated till most of the alcohol was removed and then cooled. The precipitates thus obtained were united and treated at first with stronger and afterwards with

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75-per cent. alcohol until all soluble was dissolved. A considerable residue remained which appeared to be coagulated gliadin. This was washed thoroughly with absolute alcohol and ether, and when dried weighed 5.62 grams, preparation **13**. The dissolved proteid, after filtering its solution perfectly clear, was separated by concentrating to small volume and cooling. The deposit was then treated with absolute alcohol, dissolved again in a little dilute alcohol and precipitated by pouring into absolute alcohol. The proteid, preparation **14**, separated perfectly colorless, in a finely divided state. When dried it weighed 11.66 grams.

RYE GLIADIN, *Preparation* **13**.

	I.	II.	Average.	Ash-free.
Carbon	52.36	....	52.36	52.62
Hydrogen	6.73	....	6.73	6.76
Nitrogen	17.75	17.59	17.67	17.75
Sulphur	1.18	....	1.19	1.19
Oxygen	....	....	....	21.68
				100.00
Ash	0.51			

RYE GLIADIN, *Preparation* **14**.

	I.	II.	Average.	Ash-free.
Carbon	52.74	....	52.74	52.93
Hydrogen	6.73	....	6.73	6.75
Nitrogen	17.32	17.52	17.42	17.48
Sulphur	1.23	....	1.23	1.23
Oxygen	....	....	....	21.61
				100.00
Ash	0.37			

These two preparations formed together 1.73 per cent. of the rye meal and have the composition of wheat gliadin. In order to prevent contamination of this proteid with the gum contained in rye meal, which Ritthausen* states to be freely soluble in 50-per cent. alcohol, the following method was tried.

After extracting rye meal with 10-per cent. sodium chloride brine the residue was treated with alcohol so strong that with the water retained by the meal, a mixture resulted containing about 75 per cent. of alcohol. After standing over night the extract was syphoned from the residue and greatly diluted with water. The proteid separated on standing and was filtered out and dis-

* Die Eiweisskoerper, etc., Bonn, 1872, p. 96, and Jour. f. prakt. Chem., XCIX, p. 454, and CII, p. 321.

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solved in 75-per cent. alcohol. This solution was filtered perfectly clear, concentrated, cooled and the separated proteid treated with absolute alcohol and ether and dried. The resulting preparation **15**, was perfectly white. The residual meal was again extracted with 75-per cent. alcohol and the extract filtered clear, concentrated to one-fourth its volume, cooled, the precipitated proteid again dissolved in 75-per cent. alcohol, filtered clear, concentrated, cooled, and the separated proteid washed repeatedly with water. The substance was again dissolved in dilute alcohol and the clear solution precipitated by pouring into absolute alcohol. The precipitate produced was still again dissolved in dilute alcohol and a second time precipitated by pouring into absolute alcohol. The precipitate thus resulting was dissolved in dilute alcohol and precipitated by pouring into water and adding a little salt. The final pure white precipitate was digested with absolute alcohol and ether and dried, giving preparation **16**.

RYE GLIADIN, *Preparation* **15**.

	I.	II.	Average.	Ash-free.
Carbon	52.03	52.09	52.06	52.40
Hydrogen	6.78	6.91	6.85	6.89
Nitrogen	17.80	....	17.80	17.91
Sulphur	1.23	....	1.23	1.24
Oxygen	....	....	....	21.56
				100.00
Ash	0.68			

RYE GLIADIN, *Preparation* **16**.

	I.	II.	Average.	Ash-free.
Carbon	52.74	52.65	52.70	53.03
Hydrogen	6.90	6.96	6.93	6.97
Nitrogen	17.39	....	17.39	17.50
Sulphur	1.29	....	1.29	1.30
Oxygen	....	....	....	21.20
				100.00
Ash	0.65			

Another preparation of this substance was made by extracting 3000 grams of rye flour directly with 75 per cent. alcohol. The extract was concentrated to one-fourth its volume and the proteid which separated on cooling was washed many times with distilled water and dissolved in dilute alcohol, yielding a clear solution. This was then poured into three times its volume of absolute alcohol and an opalescent mixture obtained which depos-

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ited a curdy precipitate after adding a little sodium chloride solution. The strong alcoholic solution from which this separated was clear and of a deep yellow color. The precipitate was treated with absolute alcohol as long as this was colored. During the process the substance was rubbed up to a fine powder. It was finally digested with ether for 24 hours and dried over sulphuric acid. This preparation, **17**, weighed 58 grams and was perfectly white. It formed very nearly 2 per cent. of the meal.

RYE GLIADIN, *Preparation* **17**.

Carbon	52.68
Hydrogen	6.71
Nitrogen	17.89
Sulphur	1.22
Oxygen	21.50
Ash	0.00
	100.00

In order to establish conclusively whether more than one alcohol-soluble proteid is contained in the rye-kernel, five preparations were made from the same portion of meal, by fractional precipitation. 4000 grams of rye meal were thoroughly extracted with 10-per cent. sodium chloride solution and the greater part of the bran removed by washing the meal through coarse cloth with the salt solution. The residue after decanting the salt solution was extracted with 75-per cent. alcohol, the extract was filtered clear and divided into two parts. The first part was concentrated to one-fourth and cooled, the second to one-half. The precipitated proteid from each was washed repeatedly with distilled water, dissolved in a small amount of 75-per cent. alcohol, filtered clear and precipitated by pouring into absolute alcohol. The proteid thus separated was digested with absolute alcohol and with ether. From the first portion of the alcoholic extract, preparation **18** was obtained, from the second, preparation **19**. These had the following composition:

RYE GLIADIN, *Preparation* **18**.

		Ash-free.
Carbon	51.90	52.67
Hydrogen	6.87	6.97
Nitrogen	17.50	17.76
Sulphur	1.26	1.27
Oxygen	----	21.33
		100.00
Ash	1.48	

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RYE GLIADIN, *Preparation* **19.**

		Ash-free.
Carbon	52.04	52.40
Hydrogen	6.66	6.71
Nitrogen	17.77	17.89
Sulphur	1.15	1.16
Oxygen	----	21.84
		100.00
Ash	0.71	

The water washings from these two preparations were severally mixed with a little saturated sodium chloride solution which gave a considerable precipitate in each. These precipitates were then washed superficially with distilled water, dehydrated with absolute alcohol and treated with ether. The washings from **18** yielded preparation **20,** those from **19,** preparation **21.**

RYE GLIADIN, *Preparation* **20.**

	I.	II.	Average.	Ash-free.
Carbon	51.36	51.55	51.46	53.05
Hydrogen	7.07*	6.61	6.61	6.92
Nitrogen	17.64	17.61	17.63	18.17
Sulphur	1.14	----	1.14	1.17
Oxygen	----	----	----	20.69
				100.00
Ash	3.01			

RYE GLIADIN, *Preparation* **21.**

	I.	II.	Average.	Ash-free.
Carbon	52.01	----	52.01	52.37
Hydrogen	6.88	----	6.88	6.93
Nitrogen	17.99	17.97	17.98	18.10
Sulphur	1.04	----	1.04	1.05
Oxygen	----	----	----	21.55
				100.00
Ash	0.71			

The mother liquors from which **18** and **19** separated, after concentration, were united, further concentrated and cooled. The portion so separated was washed with water, dissolved in alcohol, the solution filtered clear and precipitated by pouring into absolute alcohol and after digesting with absolute alcohol and ether yielded preparation **22.**

* Omitted in average.

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RYE GLIADIN, *Preparation* 22.

		Ash-free.
Carbon	48.44	52.46
Hydrogen	6.22	6.73
Nitrogen	16.68	17.94
Sulphur	0.91	0.99
Oxygen	----	21.88
		100.00
Ash	7.67	

SUMMARY OF ANALYSES OF RYE GLIADIN.

	9.	10.	12.	13.	14.	15.	16.
Carbon	52.84	53.23	53.11	52.62	52.93	52.40	53.03
Hydrogen	6.82	7.00	6.79	6.76	6.75	6.89	6.97
Nitrogen	17.22	17.23	17.59	17.75	17.48	17.91	17.50
Sulphur	23.12	22.54	1.44	1.19	1.23	1.24	1.30
Oxygen			21.07	21.68	21.61	21.56	21.20
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

	17.	18.	19.	20.	21.	22.	Average.
Carbon	52.68	52.67	52.40	53.05	52.37	52.46	52.75
Hydrogen	6.71	6.97	6.71	6.92	6.93	6.73	6.84
Nitrogen	17.89	17.76	17.89	18.17	18.10	17.94	17.72
Sulphur	1.22	1.27	1.16	1.17	1.05	0.99	1.21
Oxygen	21.50	21.33	21.84	20.69	21.55	21.88	21.48
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Comparing these results with those obtained by Osborne and Voorhees in analyzing gliadin from wheat* it is seen that they agree very closely, similar variations between the analyses existing in both cases. The averages of the two series of analyses agree well, as shown by the following figures:

GLIADIN.

	Wheat.	Rye.
Carbon	52.72	52.75
Hydrogen	6.86	6.84
Nitrogen	17.66	17.72
Sulphur	1.14	1.21
Oxygen	21.62	21.48
	100.00	100.00

In all their properties wheat gliadin and rye gliadin resemble each other so exactly as to leave no doubt of their chemical identity. Ritthausen, as already stated, failed to find gliadin in rye

* Amer. Chem. Jour., XV, p. 436.

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meal and described the proteid soluble in alcohol as mucedin, having a lower nitrogen and higher carbon content. This disagreement is doubtless due to impurities in Ritthausen's preparations, which, as he mentions, contained coloring matter that could not be removed. This color was probably a result of extracting with hot alcohol, which Ritthausen appears to have used in all cases, cold alcohol having given him a small yield of proteid. I had, however, no trouble in obtaining an abundant yield of gliadin with cold alcohol of 70 per cent., and thereby have extracted far less coloring matter than with hot alcohol.

D. Proteid soluble only in dilute Alkalies.

The sample of rye flour previously used is this work contained 1.52 per cent. of nitrogen. The amount of nitrogen soluble in salt solution and in dilute alcohol was determined in this flour by extracting 100 grams with a large quantity of 5-per cent. sodium chloride solution and then with 75-per cent. alcohol. The residue was then thoroughly air-dried and found to weigh 78 grams. This residue contained 0.55 per cent. of nitrogen. The 100 grams of flour therefore contained 1.52 grams of nitrogen of which 0.43 grams remained after extraction and 1.09 grams was soluble in dilute salt solution and alcohol, or in other words, 71.7 per cent. of the nitrogen was soluble in the reagents named and 28.3 per cent. was insoluble. In the wheat kernel a considerable part of the nitrogen was likewise found to be insoluble in salt solution and in dilute alcohol, but as this substance could be separated as a constituent of the gluten it was possible to prepare it in quantity and in a state of comparative purity. Since rye flour yielded no gluten on washing with water, the proteid remaining in the meal after extracting with salt solution and dilute alcohol, could be obtained only by extracting the residual meal directly with dilute potash water. All attempts, however, to thus prepare this substance resulted only in the production of small preparations of very variable composition. The gum present in the seed dissolved freely in the alkaline solution and made it impossible by any means yet discovered to thoroughly purify the preparations. For this reason nothing positive can now be said in relation to the nature or composition of this residual proteid. Since the other proteids are the same as those found in the wheat kernel it might be conjectured that this proteid is identical with glutenin. The fact that rye flour yields no gluten is, however, opposed to such

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a conclusion. It is therefore more probable that the substance in question is, partly or wholly, other than glutenin.

QUANTITIES OF THE DIFFERENT PROTEIDS IN THE RYE-KERNEL.

Owing to the gum already mentioned the filtration and treatment of the rye extracts was difficult and prolonged and the amounts of globulin, albumin and proteose could not be determined separately, as in the case of wheat. The rye flour contained 1.52 per cent. of nitrogen. If we assume that the proteids of rye contain on the average 17.6 per cent. of nitrogen, as was very nearly the case with those of wheat, and that all the nitrogen exists in proteid form, this sample of flour would contain 8.63 per cent. of proteid. We have, therefore, 2.44 per cent. of insoluble proteid and 6.19 per cent. soluble in salt solution and alcohol. We have already shown that the alcohol-soluble gliadin amounted to 4.0 per cent. of the flour and the leucosin to 0.43 per cent., there thus remains 1.76 per cent. to be divided between edestin and proteoses.

Insoluble in salt solution	2.44 per cent.
Gliadin, soluble in alcohol	4.00 "
Leucosin, " " water	0.43 "
Edestin and Proteose, soluble in salt solution	1.76 "
	8.63 "

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THE PROTEIDS OF BARLEY.

By Thomas B. Osborne.

The proteids of barley have received little attention on the part of chemists. Mulder* states that this grain contains six per cent. of albumin and plant gelatin; the latter was obtained by extracting barley meal with hot alcohol, cooling the resulting solution and treating the deposited substance with ether. The composition of this body he gave as follows:

	1.	2.
Carbon	54.93	54.75
Hydrogen	7.11	6.99
Nitrogen	15.71	15.71
Sulphur	0.57	0.62
Oxygen	21.68	21.93
	100.00	100.00

v. Bibra† names albumin, plant-gelatin and casein as constituents of barley but gives no particulars concerning these bodies further than that they all contain on the average 15.5 to 15.6 per cent. of nitrogen.

Kreusler made an investigation of the proteids of barley, the results of which are given by Ritthausen.‡ Kreusler employed coarsely ground meal and finely ground flour, the latter yielding purer preparations, the results being otherwise the same.

He states that the aqueous extract of the ground seed contains an albumin coagulated by boiling and of the following composition:

Carbon	52.86
Hydrogen	7.23
Nitrogen	15.75
Sulphur	1.18
Oxygen	22.98
	100.00

* Physiolog. Chemie, I, 306–308.

† Die Getreidearten u. das Brod. Nürnberg, 1860, p. 304.

‡ Die Eiweisskoerper &c., Bonn, 1872, page 103.

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The extract made with hot 75-per cent. alcohol contains, according to Kreusler, three proteids; gluten-casein, gluten-fibrin and mucedin.

The gluten-casein separates on cooling the hot alcoholic extract and when purified by boiling with dilute alcohol and fractionally precipitated from solution in acetic acid has the composition stated below.

1, is not corrected for ash and represents the first precipitation from a turbid solution.

2, is the second precipitation from a clear solution and is corrected for ash.

The cold alcoholic extract contains gluten-fibrin and mucedin.

The composition of these Kreusler gives as follows:

	Gluten-casein.		Gluten-fibrin.		Mucedin.	
	1.	2.	From meal.	From flour.	From meal.	From flour.
Carbon	53.84	53.25	55.23	54.55	53.19	53.97
Hydrogen	7.16	7.13	7.24	7.27	6.65	7.03
Nitrogen	16.63		15.49	15.70	16.14	16.98
Sulphur }			22.04	22.48	24.02	0.68
Oxygen }						21.34
						100.00

These proteids were supposed to be the same as those similarly named and described by Ritthausen as occurring in the wheat kernel.

So far as the writer has been able to learn the preceding summary includes all that has been published hitherto in regard to the proteids of the barley kernel that is now worthy of notice.

My preliminary examination of barley meal showed that the seeds contain proteid matters soluble in water, in sodium chloride solutions and in alcohol, and that after complete extraction with all these reagents there remains a considerable quantity of proteid which can be partly extracted by dilute potash solutions, but the greater part of which is insoluble in any reagent hitherto applied.

The material employed consisted of meal made from two-rowed barley and of a very white barley flour kindly furnished by the Health Food Co., of New York, both of which yielded proteids of the same composition and properties, the preparations derived from the flour, however, being less contaminated with coloring matter than those derived from the meal made from the entire grain, including the ground husk, which was so closely adherent, as to render its removal in the laboratory impossible.

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Proteids Soluble in Water. Leucosin. Proteose.

As an aqueous extract of any seed, is in reality a dilute saline solution, owing to the salts extracted from the seed, and as the proteid matter soluble in alcohol dissolves to a slight extent in very dilute saline solutions the proteids properly soluble in water were obtained by extracting the meal with sodium chloride solutions, dialyzing away the salts and filtering off the proteid that thereby precipitated. In this way the proteid matter, soluble in pure water, which had been extracted from the meal was obtained in solution by itself. Three kilos of barley, ground to a fine meal, were treated with nine liters of 10-per cent. salt solution, applied in successive portions, the bran being removed by washing on a coarse cloth. The starch and other suspended matter was allowed to settle out and the extract was filtered clear. This solution was then saturated with ammonium sulphate and the precipitate produced, after filtering out, was treated with 10-per cent. salt solution. The resulting liquid was filtered clear and dialyzed for five days. The globulin that separated in this process was collected on a filter, the solution was returned to the dialyzer for three days longer, and the very small additional amount of substance that separated was filtered out. The clear solution was then heated in a water bath to 65°, the water of the bath not exceeding 70°. After an hour the coagulum was filtered out, washed with warm water, alcohol and ether, and dried over sulphuric acid. This preparation, **1**, weighed 4.15 grams and when dried at 110° had the following composition :

Coagulated Barley Albumin, Leucosin. *Preparation* **1.**

Carbon	53.04
Hydrogen	6.78
Nitrogen	16.84
Sulphur	1.42
Oxygen	21.92
	100.00
Ash	0.29

Another preparation was made by treating two kilos of barley meal with 10-per cent. sodium chloride solution, squeezing out in a press and repeating the process on the residue. The filtered extract was saturated with ammonium sulphate, the precipitate dissolved in dilute salt solution, subjected to dialysis and when freed from chlorides filtered and heated to 65° in a water bath of

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70°. The coagulum produced was washed thoroughly with hot water, alcohol and ether and dried over sulphuric acid. This preparation, 2, weighed 2.3 grams and when dried at 110° had the following composition:

Coagulated Barley Albumin, Leucosin.	*Preparation* 2.
Carbon	52.67
Hydrogen	6.77
Nitrogen	16.41
Sulphur } Oxygen }	24.15
	100.00
Ash	0.31

As this body separated slowly when its solutions were heated to 65° it was thought possible that more than one albumin was present, which if a fact might be shown by analysis of preparations precipitated in successive fractions.

Accordingly six kilos of barley meal were extracted with 10-per cent. salt solution and the clear filtered extract saturated with ammonium sulphate. The precipitate produced was dissolved in brine and the solution, after filtering clear, was dialyzed until all the globulin had precipitated. It was then again filtered clear and in order to obtain a concentrated solution the filtrate was saturated with ammonium sulphate, the precipitate formed was dissolved in water and this solution was filtered clear and dialyzed. After six days only a very little more globulin had separated, which was filtered out and a portion of the clear solution was tested carefully for its coagulation point. When slowly heated in a double water bath it became faintly turbid at 39° and but very little more so at 49°. The turbidity then rapidly increased, flocks appearing at 56°. After heating at 56° for twenty minutes the solution was filtered and again heated. Turbidity occurred at 50° and flocks formed at 60°. After heating to 65° and holding at this temperature for some time the solution was filtered and again heated. Thereupon the turbidity took place at 70° and a very few flocks formed at 74°. The solution still had a just detectable acid reaction. The entire solution was then heated with great care to precisely 56° in a large water bath, the temperature of which did not exceed 57°. After keeping at this temperature for an hour the coagulum was filtered out, washed with hot water, alcohol and ether and dried over sulphuric acid

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This preparation, **3**, weighed 0.36 gram and contained, when dried, without correction for ash, 16.48 per cent. of nitrogen.

The filtrate from preparation, **3**, was then heated to just 60° for three hours and the second coagulum filtered off and treated as the first had been. This preparation, **4**, weighed 0.4 gram and contained, without correcting for ash, 16.74 per cent. of nitrogen. Another part of this same extract after freeing from globulin as above described was dialyzed into alcohol for three days whereby the solution was concentrated and the proteid partly precipitated. In order to separate the albumin from any proteose thrown down with it, the precipitate produced by alcohol-dialysis was digested with absolute alcohol for three days longer and then washed thoroughly with water. A considerable part of the albumin was thus rendered insoluble in water, and after being further washed with absolute alcohol and ether was dried over sulphuric acid and found to weigh 0.51 gram. This preparation, **5**, contained 16.30 per cent. of nitrogen without correcting for ash.

Another preparation of albumin was made in the same way, in order to obtain a larger quantity for complete analysis. Six kilos of barley flour were mixed with 28 liters of 10-per cent. salt solution and 17 liters of clear filtrate obtained, which was saturated with ammonium sulphate. The precipitate produced was dissolved as far as possible in 10-per cent. salt solution, filtered clear, and in order to reduce the volume of the solution it was saturated with ammonium sulphate, the precipitate dissolved in 1000 c. c. of water and dialyzed until entirely free from globulin. The solution was then filtered and dialyzed into alcohol. After being concentrated, absolute alcohol was added and the precipitate filtered off, washed with absolute alcohol and ether and dried over sulphuric acid. This preparation, **6**, weighed 4.1 grams. It was then digested with water and the insoluble matter washed thoroughly with water, alcohol and ether, dried over sulphuric acid, and had the following composition when dried at 110°:

Coagulated Barley Albumin, Leucosin. *Preparation* **6.**	
Carbon	52.71
Hydrogen	6.78
Nitrogen	16.93
Sulphur	1.51
Oxygen	22.07
	100.00
Ash	0.50

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SUMMARY OF ANALYSES OF COAGULATED BARLEY ALBUMIN—LEUCOSIN.

	1.	2.	3.*	4.*	5.*†	6.†	Average.
Carbon	53.04	52.67	----	---	----	52.71	52.81
Hydrogen	6.78	6.77	----	---	----	6.78	6.78
Nitrogen	16.84	16.41	16.48	16.74	16.30	16.93	16.62
Sulphur	1.42	24.15	----	----	----	1.51	1.47
Oxygen	21.92					22.07	22.32
	100.00	100.00				100.00	100.00

If this proteid is compared with the leucosin‡ obtained from the wheat and rye kernels it will be seen that the three are almost identical in composition.

	LEUCOSIN.		
	Wheat.	Rye.	Barley.
Carbon	53.02*	52.97	52.81
Hydrogen	6.84	6.79	6.78
Nitrogen	16.80	16.66	16.62
Sulphur	1.28	1.35	1.47
Oxygen	22.06	22.23	22.32
	100.00	100.00	100.00

The aqueous extract of the barley kernel contains also a small quantity of one or more proteoses, but owing to the great difficulties encountered in attempting to separate these no pure preparations have been obtained.

PROTEID SOLUBLE IN SODIUM CHLORIDE SOLUTION. EDESTIN.

The large amount of gum extracted from barley meal by salt solution renders it very difficult to prepare the globulin in anything like a pure state. This difficulty is further increased by the readiness with which the globulin passes into the insoluble or albuminate condition and is thus lost for further purification. In only three cases was it possible to redissolve and reprecipitate this proteid in sufficient quantity for analysis. In all the extracts made, a considerable amount of globulin was precipitated by dialysis in the form of minute spheroids. So far as noticed, this globulin resembled in all respects that found in wheat and rye. It was readily and completely precipitated from salt solution by dialysis and also by adding acid. When dissolved in 10-per cent. sodium chloride solution and heated, turbidity occurred at 90° but no

* Not corrected for ash. † Coagulated by alcohol.

‡ Report of the Conn. Agricultural Experiment Station, 1893, p. 179.

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coagulum formed until the solution was boiled and then only a small part of the dissolved substance separated.

Three kilos of barley meal were extracted with 10-per cent. salt solution, the filtered extract saturated with ammonium sulphate and the resulting precipitate filtered out, dissolved in 10-per cent. brine and the insoluble matter removed by filtration after adding a *very* small quantity of two-tenths-per cent. potash water in order to neutralize the slight acid reaction of the extract. The solution was then filtered clear and dialyzed for four days. The proteid separated in the form of small spheroids which were filtered out, washed with water, alcohol and ether, and after drying over sulphuric acid found to weigh 4.02 grams. This preparation was dissolved in 10-per cent. salt solution and again submitted to dialysis. After the proteid had precipitated it was filtered out, washed with water, alcohol and ether, and the final preparation, 7, when dried at 110°, had the following composition:

BARLEY GLOBULIN, EDESTIN, *Preparation* 7.

Carbon	51.43
Hydrogen	6.71
Nitrogen	18.14
Sulphur, Oxygen	23.72
	100.00
Ash	0.48

Again six kilos of barley flour were extracted with 10-per cent. salt solution, the filtered extract saturated with ammonium sulphate, the resulting precipitate dissolved in salt solution and dialyzed. The precipitated globulin was again dissolved in 10-per cent. salt solution and precipitated a second time by dialysis. 1.9 grams of preparation 8 were obtained, having the following composition:

BARLEY GLOBULIN, EDESTIN, *Preparation* 8.

Carbon	50.82
Hydrogen	6.76
Nitrogen	18.16
Sulphur, Oxygen	24.26
	100.00
Ash	0.37

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Another preparation was made in the same way, save that after dissolving the ammonium sulphate precipitate in salt solution, the proteids were again precipitated by saturation with ammonium sulphate and redissolved in brine, thus yielding a solution of smaller volume which was then dialyzed. After five days' dialysis, the chlorides having been removed, the precipitated globulin was treated in the usual manner and found to weigh 1.85 grams. This preparation, 9, had the following composition:

BARLEY GLOBULIN, EDESTIN, *Preparation* 9.

Carbon	50.40
Hydrogen	6.48
Nitrogen	18.00
Sulphur } Oxygen }	25.12
	100.00
Ash	0.44

The foregoing analyses, although not showing the agreement to be desired, are on the whole sufficiently alike to warrant their publication, and for the sake of comparison they are here tabulated.

BARLEY GLOBULIN, EDESTIN.

	7.	8.	9.	Average.
Carbon	51.43	50.82	50.40	50.88
Hydrogen	6.71	6.76	6.48	6.65
Nitrogen	18.14	18.16	18.00	18.10
Sulphur } Oxygen }	23.72	24.26	25.12	24.37
	100.00	100.00	100.00	100.00

In view of the close resemblance in properties and similarity in composition it is the writer's opinion that this globulin is the same as that found in a large number of other seeds and previously described under the name edestin.* The following table affords a comparison of the composition of this proteid from its different sources.

EDESTIN.

	Wheat.	Maize.	Hemp-seed.	Castor-bean.	Squash-seed.	Flax-seed.	Cotton Seed.	Rye.	Barley.
C.	51.03	51.71	51.28	51.31	51.66	51.48	51.71	51.19	50.88
H.	6.85	6.85	6.84	6.97	6.89	6.94	6.86	6.74	6.65
N.	18.39	18.12	18.84	18.75	18.51	18.60	18.64	18.19	18.10
S.	0.69	0.86	0.87	0.76	0.88	0.81	0.62	23.88	24.37
O.	23.04	22.46	22.17	22.21	22.06	22.17	22.17		
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Report Conn. Agricultural Experiment Station, 1893, pp. 179 and 216.

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On comparing the above analyses it will be seen that the preparations obtained from the cereals show the greatest deviation from the average of these figures. This is unquestionably due to the fact that in these seeds this substance is present in small quantity and is associated with other bodies so that it has been impossible to prepare it from them in a state of perfect purity.

Proteid soluble in Dilute Alcohol. Hordein.

After extracting 500 grams of barley meal with brine the residue was treated with alcohol added in sufficient quantity to form with the water retained by the meal, an alcohol of approximately 75-per cent. After digesting a short time the meal was squeezed out and again treated with 75-per cent. alcohol, and pressed out. The united alcoholic extracts were then filtered clear, concentrated to small volume on a water bath, cooled and the proteid thus separated washed thoroughly by kneading with distilled water. The separated substance now presented every appearance of gliadin, the proteid similarly obtained from wheat and rye. It was dissolved in a little dilute alcohol in which it was very readily soluble with the exception of a slight residue of coagulated proteid which rendered filtration extremely difficult. The solution was then precipitated by pouring into absolute alcohol and the precipitate digested with absolute alcohol, rubbed to a powder while still moist with alcohol and treated with ether. When dried over sulphuric acid this preparation, **10**, weighed 4.54 grams and when dried at 110° gave on analysis the following results:

Barley Proteid, *Preparation* **10.**

	I.	II.	Average.
Carbon	53.83	53.93	53.88
Hydrogen	6.72	6.92	6.82
Nitrogen	17.32	----	17.32
Sulphur } Oxygen }	----	----	21.98
			100.00
Ash			0.22

Another extract was made by treating 500 grams of barley meal with three liters of alcohol of 0.9 specific gravity applied directly to the freshly ground meal. The extract which had a red-brown color was squeezed out in a press and concentrated to about one-eighth of its volume. After standing over night the mother

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liquor was poured off from the proteid which had separated in a firm mass on the bottom of the dish.

This was then dissolved in dilute alcohol and precipitated by pouring into absolute alcohol. The resulting precipitate was washed with absolute alcohol, digested with ether, dried over sulphuric acid and found to weigh 12.3 grams. This preparation, **11**, when dried at 110°, had the following composition:

BARLEY PROTEID, *Preparation* **11**.

Carbon	53.78
Hydrogen	6.51
Nitrogen	17.27
Sulphur	0.95
Oxygen	21.49
	100.00
Ash	0.19

The remainder of preparation **11** was then dissolved in dilute alcohol and, after filtering clear, poured into distilled water and precipitated by adding a few drops of sodium chloride solution. This substance was again dissolved in dilute alcohol and precipitated by pouring into absolute alcohol. After treating with ether and drying at 110°, this preparation, **12**, was analyzed with the following results:

BARLEY PROTEID, *Preparation* **12**.

Carbon	53.78
Hydrogen	6.82
Nitrogen	17.16
Sulphur	0.93
Oxygen	21.31
	100.00
Ash	0.86

Three kilos of barley meal were treated with 10-per cent. salt solution and washed on a coarse cloth until only the bran and larger particles of meal remained. This residue was then extracted with alcohol of 0.9 sp. gr. yielding a deep red solution, which was filtered through animal charcoal, but only a part of the coloring matter was removed. The clear solution was next concentrated on a water bath, poured into absolute alcohol and the resulting precipitate digested with absolute alcohol and treated with ether, giving preparation **13**, weighing 30 grams and when dry having the following composition:

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BARLEY PROTEID, *Preparation* 13.

	I.	II.	Average.
Carbon	53.80	53.70	53.75
Hydrogen	....	6.78	6.78
Nitrogen	17.48	17.33	17.41
Sulphur	0.93	....	0.93
Oxygen	....	....	21.13
			100.00
Ash		....	0.25

A portion of the solution from which preparation **13** had been obtained was precipitated separately by pouring into strong alcohol and adding a few drops of salt solution. The precipitate was treated in the usual manner and gave a preparation, **14**, containing much less coloring matter than the preceding and having the following composition:

BARLEY PROTEID, *Preparation* 14.

Carbon	54.32
Hydrogen	6.74
Nitrogen	17.13
Sulphur, Oxygen	21.81
	100.00
Ash	1.43

The starchy portion of the barley meal which had been washed through the cloth, as described, was thoroughly extracted with salt solution and then with dilute alcohol, the extraction being repeated until the proteid was completely removed. The united extracts were filtered and concentrated to two-thirds of their volume by distillation when the solution was poured into a dish and the evaporation continued. The proteid separated as a skin on the surface of the liquid and as a solid mass on the bottom of the dish. When reduced to about one-half the volume of the original liquid the hot mother liquor was decanted from the separated proteid which formed a tough mass of a pink color. This was washed with water and redissolved in dilute alcohol, giving a deep red solution which was poured into absolute alcohol and the mass of substance that separated was cut up with scissors into small pieces and digested with absolute alcohol and with ether. When dried over sulphuric acid this preparation, **15**, was pinkish in color and weighed 30 grams. Dried at 110° and analyzed the following results were obtained:

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BARLEY PROTEID, *Preparation* 15.

Carbon	54.00
Hydrogen	6.72
Nitrogen	17.49
Sulphur, Oxygen	21.79
	100.00
Ash	0.95

The mother liquor, decanted from preparation **15**, was still further concentrated and allowed to cool over night. Only a little substance separated which however was washed with water, redissolved in dilute alcohol and precipitated by pouring into much distilled water to which a little salt had been added. On standing about 36 hours the milky solution cleared and the proteid was found in a transparent layer at the bottom of the vessel. After treating with absolute alcohol and ether and drying over sulphuric acid, preparation **16** was obtained weighing 7 grams and having when dried, the following composition:

BARLEY PROTEID. *Preparation* 16.

Carbon	53.90
Hydrogen	6.63
Nitrogen	17.08
Oxygen, Sulphur	22.39
	100.00
Ash	0.23

As this proteid resembled gliadin so closely in its physical and chemical properties it seemed important to subject it to very thorough fractional precipitation in order to determine whether it was a mixture of gliadin with another body or a new, distinct proteid. Another extract was made by treating three kilos of freshly ground barley meal with 10-per cent. salt solution, squeezing out in a press and treating the residue again in the same way. The meal residue was then mixed with alcohol in quantity sufficient to make with the water retained by the meal an alcohol of about 40-per cent. After squeezing out the liquid, alcohol was again added to the residual meal sufficient to increase the strength of the solvent to 75-per cent. After digesting for some time the extract was squeezed out and found less colored than the first dilute alcohol extract. This second extract was concentrated by

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distillation to small volume and cooled giving a deposit of proteid much whiter than any previously made. The mother liquor from this precipitate was poured into absolute alcohol and a second precipitate obtained. The two precipitates, when united, dehydrated in the usual way, treated with ether, and dried over sulphuric acid weighed 22 grams. Dried at 110° this substance had the following composition:

BARLEY PROTEID. *Preparation* 17.

Carbon	54.30
Hydrogen	6.67
Nitrogen	17.47
Sulphur	0.84
Oxygen	20.72
	100.00

About 18 grams of this preparation were dissolved in alcohol of 0.9 specific gravity and absolute alcohol was added until a considerable precipitate resulted, when the mixture was heated on a water bath until the precipitate dissolved. The solution was then cooled and after standing sometime the mother liquor was decanted from the separated substance. This precipitate was marked I. The solution decanted from I, was further treated with absolute alcohol and a second precipitate II, obtained in the same way. The mother liquor from II was mixed with a large quantity of absolute alcohol and, as the proteid did not separate, a few drops of salt solution were added and the resulting precipitate III filtered off and treated with absolute alcohol and ether in the usual manner.

In the first place, precipitate I was dissolved in a small quantity of 75-per cent. alcohol and absolute alcohol was added until the precipitate began to reappear. The whole was heated until this precipitate again dissolved whereupon the solution was cooled. The substance which separated settled out leaving the solution milky. The mother liquor was decanted from the small amount of deeply colored proteid which adhered to the bottom of the beaker, and this deposit was dissolved in a little 75-per cent. alcohol, treated with absolute alcoho and the opalescent solution so produced mixed with a little ether. This gave a very small precipitate, almost black in color and very sticky. The solution decanted from this small deposit was treated with a drop of potassium acetate solution

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and the resulting precipitate after washing with absolute alcohol and ether was dried over sulphuric acid. It formed a light pink powder, preparation **18**, weighing 0.65 gram and when dry contained, ash free, 16.60 per cent. of nitrogen. Its ash content was 1.04 per cent. The mother liquor, decanted from the first precipitation of **18**, was treated with a drop of potassium acetate solution and the precipitate produced allowed to settle. After standing, the substance settled out and adhered to the bottom of the beaker in a solid mass, from which the clear supernatant solution was decanted. This solution after treatment with absolute alcohol yielded a precipitate which, washed with absolute alcohol and ether and dried, formed preparation **19** weighing 1.79 grams and having the following composition:

BARLEY PROTEID. *Preparation* **19.**

Carbon	53.85
Hydrogen	6.69
Nitrogen	17.22
Sulphur, Oxygen	22.24
	100.00
Ash	0.40

The substance deposited after the addition of potassium acetate to the solution from which **19** was derived, was dissolved in 75-per cent. alcohol, absolute alcohol added to the solution and the resulting precipitate dissolved by heating. On cooling, a part of the proteid separated and after this had settled, the liquid was decanted and mixed with absolute alcohol, and on treating the precipitate in the usual manner preparation **20** was obtained, which when dried weighed 1.18 gram and gave the following results on analysis:

BARLEY PROTEID. *Preparation* **20.**

Carbon	54.33
Hydrogen	6.81
Nitrogen	16.93
Sulphur, Oxygen	21.93
	100.00
Ash	0.58

The substance deposited by cooling the solution from which **20** was obtained was only partly soluble in dilute alcohol. It was

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accordingly treated with 75-per cent. alcohol and allowed to stand until the insoluble matter had settled out. The clear liquid was then decanted and completely precipitated with absolute alcohol. The separated substance was washed with absolute alcohol and ether and when dry weighed 0.81 gram. This preparation, **21**, contained ash-free, 16.65 per cent. of nitrogen and 0.32 per cent. of ash. The insoluble matter just described, after washing by decantation with 75-per cent. alcohol, was treated in the usual manner and yielded preparation **22**, weighing 1.56 gram and having the following composition:

BARLEY PROTEID. *Preparation* **22**.

Carbon	53.91
Hydrogen	6.77
Nitrogen	17.00
Sulphur } Oxygen }	22.32
	100.00
Ash	0.71

Precipitate II was dissolved in a little 75-per cent. alcohol and the solution mixed with absolute alcohol. The resulting precipitate (*a*) was dissolved by heating and the solution cooled, whereupon a part (*b*) of the proteid was precipitated. The supernatant solution was poured off, mixed with absolute alcohol and this precipitate (*c*) which contained all the proteid remaining was dehydrated with absolute alcohol and washed with ether, giving preparation **23**, weighing 2.2 grams and having when dry the following composition:

BARLEY PROTEID. *Preparation* **23**.

	I.	II.	Average.
Carbon	54.63	54.68	54.65
Hydrogen	6.62	6.50	6.56
Nitrogen	17.16	....	17.16
Sulphur } Oxygen }	....	....	21.63
			100.00
Ash			0.32

The substance (*b*) deposited on cooling the solution as above described, was dissolved in 75-per cent. alcohol and partly precipitated by adding absolute alcohol. After redissolving the precipitate by the application of heat, the solution was cooled and

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allowed to stand some time to deposit the precipitate which formed. The liquid was then decanted and the separated substance treated with absolute alcohol and ether, yielding preparation **24**, weighing 3.11 grams and having the following composition after drying at 110°.

BARLEY PROTEID. *Preparation* **24**.

Carbon	54.27
Hydrogen	6.67
Nitrogen	17.39
Sulphur, Oxygen	21.67
	100.00
Ash	0.32

To the solution from which **24** separated absolute alcohol was added in considerable quantity and the proteid thus thrown down was dehydrated with absolute alcohol and washed with ether. When dried this preparation, **25**, weighed 0.87 gram and, without correction for ash contained 17.28 per cent. of nitrogen.

Precipitate III was treated with absolute alcohol and with ether, and dried over sulphuric acid. It weighed 1.63 grams and its composition after complete drying was :

BARLEY PROTEID. *Preparation* **26**.

Carbon	53.39
Hydrogen	7.02
Nitrogen	17.49
Sulphur, Oxygen	22.10
	100.00
Ash	0.59

If these figures are compared it will be seen that no fractional separation has been effected, the variation in the results being no greater than in the preparations previously described. Preparation **18** is low in nitrogen, but this is doubtless due to its containing nearly all the impurities precipitable from the solution. Preparation **21** is also low in nitrogen but this was the most colored of all the preparations and as it was also small in quantity the accuracy of the analysis could not be confirmed. Excluding these two preparations the results agree fairly as shown by the following table.

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SUMMARY OF THE PRECEDING FRACTIONAL PRECIPITATES.

	19.	20.	22.	23.	24.	25.	26.	Original substance 17
Carbon	53.85	54.33	53.91	54.65	54.27	....	53.39	54.30
Hydrogen	6.69	6.81	6.77	6.56	6.67	....	7.02	6.67
Nitrogen	17.22	16.93	17.00	17.16	17.39	17.28	17.49	17.47
Sulphur } Oxygen }	22.24	21.93	22.32	21.63	21.67	....	22.10	21.56
	100.00	100.00	100.00	100.00	100.00		100.00	100.00
Weight	1.79	1.18	1.56	2.2	3.11	0.87	1.63	18.00

As all the preceding preparations were made by extracting barley meal which contained a large quantity of bran, they were much contaminated with coloring matter.

In order to obtain products free from color 880 grams of fine ground "pearled barley" (a commercial preparation of barley made by rubbing off the outer coat of the grain), were treated with salt solution and after squeezing out the excess of liquid the residue was digested with 75-per cent. alcohol. The extract was then filtered, concentrated to small volume, cooled and the mother liquor decanted from the separated proteid. This was then dissolved in dilute alcohol, the solution poured into distilled water and the proteid thrown down by adding a little salt. The precipitate was again dissolved in a small amount of dilute alcohol and reprecipitated by pouring into absolute alcohol, digested with absolute alcohol for some time, then with ether, dried over sulphuric acid and found to weigh 8 grams. This preparation, **27**, was pure white and had the following composition when thoroughly dried:

BARLEY PROTEID, *Preparation* **27**.

Carbon	54.37
Hydrogen	6.81
Nitrogen	17.33
Sulphur	0.88
Oxygen	20.61
	100.00
Ash	0.48

Another preparation was made by extracting six kilos of barley flour with salt solution and then treating the residue with alcohol added in sufficient quantity to make with the water of the brine which still adhered to the meal as nearly as possible 75-per cent. alcohol. After standing over night the extract was filtered off,

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concentrated to about one-third its original volume and cooled slightly. The proteid that now separated out from the hot solution was removed from the liquid, rinsed with water, dissolved in a very little dilute alcohol to a thick syrup, and reprecipitated by pouring into absolute alcohol. The substance was then cut up into small pieces and digested with absolute alcohol and also with ether. When dried over sulphuric acid 78 grams of a pure white preparation were obtained. Twenty-five grams of this were then dissolved in 75-per cent. alcohol and the clear solution poured into a large volume of distilled water. A part of the substance separated, leaving the liquid milky. The milky solution was decanted from the separated substance and the latter was washed with water in which some of it dissolved. The turbid liquid and washings were united and precipitated with a little salt solution. After standing over night the proteid separated as a transparent viscid liquid on the bottom of the vessel in the same way as gliadin does under similar conditions. After decanting the supernatant liquid the deposit was dissolved in dilute alcohol and precipitated by pouring its solution into absolute alcohol. The separated proteid was then digested with absolute alcohol and with ether and dried over sulphuric acid. A pure white preparation, 28, resulted, which when dried at 110° had the following composition:

BARLEY PROTEID, *Preparation* 28.

Carbon	54.02
Hydrogen	6.79
Nitrogen	17.38
Sulphur	0.84
Oxygen	20.97
	100.00
Ash	1.00

The mass which separated on pouring the alcoholic solution into water, as above described, was dissolved in 75-per cent. alcohol and, as it contained a little insoluble proteid which rendered filtration impossible, the solution was allowed to stand over night. The clear supernatant solution was then poured off and concentrated to about one-third of its volume and cooled. The proteid which separated was again dissolved in dilute alcohol and precipitated by pouring into absolute alcohol. After thorough dehydration with absolute alcohol and digestion with ether the sub-

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stance was dried over sulphuric acid and yielded preparation 29, which was white in color and weighed 5.46 grams. This substance when dried had the following composition:

BARLEY PROTEID, *Preparation* 29.

	I.	II.	Average.
Carbon	54.48	54.54	54.51
Hydrogen	6.70	6.79	6.75
Nitrogen	17.22	17.18	17.20
Sulphur } Oxygen }	21.60	21.49	21.54
	100.00	100.00	100.00
Ash			0.32

Another preparation was made without heating, by pouring a part of the original extract from which preparations 28 and 29 were derived into a large amount of distilled water and allowing the separated substance to deposit. After some time this settled and the supernatant liquid was poured off, the precipitate washed with water, dissolved in cold dilute alcohol and the solution poured into absolute alcohol. The precipitate produced was digested with absolute alcohol and then with ether and dried over sulphuric acid yielding a pure white preparation having when dry the following composition:

BARLEY PROTEID, *Preparation* 30.

Carbon	54.23
Hydrogen	6.83
Nitrogen	17.27
Sulphur	0.75
Oxygen	20.92
	100.00
Ash	0.17

In order to obtain a larger quantity of a colorless preparation, five kilos of barley flour were treated with 10.5 liters of 75-per cent. alcohol and after standing some time the extract was filtered off and 6 liters of clear solution obtained. This was then concentrated to one-third its volume and rapidly cooled. The proteid separated as a bulky plastic mass, which, after decanting the mother liquor, was macerated with about 500 c. c. of distilled water, the washings were poured off and the mass of proteid dissolved in 500 c. c. of 75-per cent. alcohol, yielding a solution of a pale yellowish brown tint. This solution was poured in a thin stream

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into a quantity of distilled water and the separated proteid, after removal from the liquid, was again dissolved in 75-per cent. alcohol and the perfectly clear solution poured in a small stream into a large quantity of absolute alcohol. As the soluble salts had been almost completely removed the proteid did not separate even after admixture of 800 c. c. of absolute ether. Three or four c. c. of salt solution were therefore added to the milky liquid and an immediate precipitate resulted which rapidly settled leaving the solution clear and free from proteid. This mixture of absolute alcohol and ether retained all the fat present in the proteid before precipitation and also some coloring matter, the liquid being yellow. The solution was decanted and the voluminous precipitate treated with successive portions of absolute alcohol and obtained as a snow white granular substance, weighing when dried over sulphuric acid 93 grams. This preparation, **31,** had the following composition when dried at 110°:

BARLEY PROTEID. *Preparation* **31.**

	I.	II.	Average.
Carbon	54.18	54.31	54.25
Hydrogen	6.98	6.65	6.82
Nitrogen	17.20	17.30	17.25
Sulphur	0.84	....	0.84
Oxygen	....	....	20.84
			100.00
Ash	....	....	0.09

In order to make certain that this proteid, which so closely resembled gliadin in every respect but composition, was not that substance contaminated with fat, a portion of this preparation was ground to a very fine powder and washed for a long time with hot ether in an extraction apparatus. Only a trace of substance was removed by this treatment and the proteid after drying had the same composition as before as the following figures show:

BARLEY PROTEID. *Preparation* **32.**

Carbon	54.20
Hydrogen	6.58
Nitrogen	17.07
Sulphur	0.91
Oxygen	21.24
	100.00
Ash	0.25

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Another portion of **31** was dissolved in two-tenths per cent. potash water yielding a clear solution which was precipitated by neutralization with two-tenths per cent. hydrochloric acid. The precipitate was washed with water, dehydrated with absolute alcohol, washed with ether and analyzed with the following results:

BARLEY PROTEID. *Preparation* **33.**

Carbon	54.21
Hydrogen	6.87
Nitrogen	17.12
Sulphur	0.76
Oxygen	21.04
	100.00
Ash	0.25

Preparation **31** was then subjected to fractional precipitation in order to make sure that it was not a mixture of two or more proteids. Twenty-five grams were dissolved in 300 c. c. of alcohol of 0.865 specific gravity by heating on a water bath and the solution was quickly cooled. After adding a few drops of 10-per cent. salt solution the most of the proteid separated in a coherent mass leaving the liquid clear. After decantation the residue was treated in the same way again, the decanted solutions being united. The residue was again dissolved and absolute alcohol added to the hot solution until a considerable precipitate resulted, when it was heated until clear and then cooled. A few drops of salt solution were then added and the proteid precipitated leaving the solution slightly milky. This liquid was joined to the two solutions from which the proteid had been previously separated and a little more salt solution added to the mixture thereby precipitating the remainder of the dissolved proteid. After decanting the liquid from the separated substance the latter was treated with absolute alcohol and gave preparation **34**, representing the fraction soluble in the strongest alcohol and having when dry the following composition:

BARLEY PROTEID. *Preparation* **34.**

Carbon	54.32
Hydrogen	6.78
Nitrogen	17.02
Sulphur	0.94
Oxygen	20.94
	100.00
Ash	0.21

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The proteid which had been precipitated during the preparation of this substance as just described was dissolved in alcohol of 0.865 specific gravity and the solution cooled rapidly by immersing in cold water. When a part of the substance had separated the solution was decanted and the separated substance treated with absolute alcohol. Preparation **35** was thus obtained which gave the following figures on analysis:

BARLEY PROTEID. *Preparation* **35.**

Carbon	54.47
Hydrogen	7.01
Nitrogen	17.15
Sulphur	0.74
Oxygen	20.63
	100.00
Ash	0.43

The above preparation represented the portion least soluble in strong alcohol. The solution decanted from this preparation was precipitated with absolute alcohol and a few drops of salt solution and the resulting precipitate after the usual treatment yielded preparation **36** having the following composition:

BARLEY PROTEID. *Preparation* **36.**

Carbon	54.37
Hydrogen	6.81
Nitrogen	17.30
Sulphur	0.84
Oxygen	20.68
	100.00
Ash	0.38

The following table includes all analyses of the preparations which were free from coloring matter. (See also the next page.)

HORDEIN. BARLEY PROTEID SOLUBLE IN DILUTE ALCOHOL.

	27.	28.	29.	30.	31.	32.
Carbon	54.37	54.02	54.51	54.23	54.25	54.20
Hydrogen	6.81	6.79	6.75	6.83	6.82	6.58
Nitrogen	17.33	17.38	17.20	17.27	17.25	17.07
Sulphur	0.88	0.84	21.54	0.75	0.84	0.91
Oxygen	20.61	20.97		20.92	20.84	21.24
	100.00	100.00	100.00	100.00	100.00	100.00

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	33.	34.	35.	36.	Average.
Carbon	54.21	54.32	54.47	54.37	54.29
Hydrogen	6.87	6.78	7.01	6.81	6.80
Nitrogen	17.12	17.02	17.15	17.30	17.21
Sulphur	0.76	0.94	0.74	0.84	0.83
Oxygen	21.04	20.94	20.63	20.68	20.87
	100.00	100.00	100.00	100.00	100.00

This body differs essentially from all the well defined plant-proteids now known. As it appears to be characteristic of barley, I propose to adopt for it the latterly disused name *hordein*, which was first applied about 1820 by Proust* and ten years later by Hermbstädt † to certain products of their attempts to isolate the proximate principles of this cereal.

Hordein appears to have been obtained nearly pure from barley flour by Kreusler, as shown by the following comparison of his analysis with the average above given.

BARLEY PROTEID SOLUBLE IN DILUTE ALCOHOL.

	Kreusler.	Osborne.
Carbon	53.97	54.29
Hydrogen	7.03	6.80
Nitrogen	16.98	17.21
Sulphur	0.68	0.83
Oxygen	21.34	20.87
	100.00	100.00

Ritthausen regarded this proteid as identical with the mucedin believed by him to occur in wheat and rye, but which, as my investigations prove, does not exist in those grains.

Toward water my different preparations of hordein behave somewhat differently. Preparations dried over sulphuric acid and still retaining a little alcohol dissolve in cold water to a greater or less extent according to the amount of alcohol present. When dried completely at 110°, so that all the alcohol is removed, very little hordein dissolves in cold water and slightly more on raising the temperature. Solutions thus made with hot water do not precipitate on cooling or coagulate on boiling although they give no inconsiderable precipitates on adding salt. A large number of preparations of this proteid and of wheat gliadin were thus tested and compared under similar conditions. The gliadin

* Ann. Chim. phys., V, 337.

† Jour. of Techn. Chem., XII, 46.

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showed variations in solubility in the same way as the barley proteids, but throughout was much more soluble than the latter, yielding solutions with warm water which were precipitated by cooling. As drying at 110° tends to render more or less of these proteids insoluble in 75-per cent. alcohol it is not possible to say definitely whether the difference was due to original difference in properties of the two proteids tested or to the drying. It is the opinion of the writer that the hordein of barley is decidedly less soluble in water than the gliadin of wheat.

Toward alcohol the hordein behaves, so far as could be detected, exactly like gliadin. In very dilute acids and alkalies it is readily soluble and is precipitated by neutralization. Dissolved in concentrated hydrochloric acid a beautiful crimson color is produced similar to that given by gliadin under like conditions. With a warm mixture of equal volumes of water and concentrated sulphuric acid a red color is given by hordein, not a purple red as by gliadin.

The most marked difference between hordein and gliadin is in composition, since hordein contains one and a half per cent. more carbon, one-half per cent. less nitrogen, and three-tenths per cent. less sulphur than gliadin.

In the extraction last described, 5000 grams of barley flour were treated with 10.5 liters of alcohol, and the extract obtained measured 6 liters, which was equivalent to 57.1 per cent. of the whole solution employed. If we assume, as is very nearly true, that this was equal to a complete extraction of 57.1 per cent. of the flour, the proteid obtained was equivalent to all the alcohol soluble proteid contained in 2855 grams of flour. In addition to the 93 grams of proteid above described, there was obtained a further quantity weighing when thoroughly dried over sulphuric acid 17.5 grams, thus making in all 110.5 grams. This quantity is 3.87 per cent. of the 2855 grams extracted. In order to confirm these figures 500 grams of barley flour were extracted with 2 liters of hot 75-per cent. alcohol, squeezed out in a press and the residual meal treated again in the same way with another liter of alcohol and the united extracts filtered clear and concentrated by evaporation. All the proteid contained in the solution separated on cooling and was washed with ether, then dehydrated with absolute alcohol, again digested with ether and dried completely over sulphuric acid. 20.2 grams of proteid were thus obtained equal to 4.04 per cent. of the flour. We may therefore assume that this barley flour contained about 4 per cent. of the alcohol-soluble proteid, hordein.

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Proteid insoluble in Water, Saline Solutions and Alcohol.

The proteids thus far described form only a part of the total proteids of the seed. One hundred grams of barley flour were extracted, first, with a large excess of 5-per cent. salt solution and then, repeatedly, with hot 75-per cent. alcohol. The residue, washed with absolute alcohol and thoroughly air dried, weighed 71 grams and contained 1.07 per cent. of nitrogen. The air dry flour before extraction contained 1.83 per cent. of nitrogen. The 100 grams of flour therefore contained 1.83 grams of nitrogen and the residue after extraction contained 0.76 grams. The nitrogen removed by the solvents therefore amounted to 58.3 per cent. of the whole.

If we assume that the nitrogen all belonged to proteid matter containing 17 per cent. of nitrogen, the flour included 10.76 per cent. of proteids, of which 58.3 per cent. was soluble in the reagents used in extracting the proteids already described. We have therefore $10.76-6.28=4.48$ per cent. of proteid unextracted. It was only possible to obtain this proteid by treating the residue with potash water. All attempts, however, to thus prepare it in quantity sufficient to yield preparations of even approximate purity resulted in complete failure.

The previous extraction of the flour to remove the proteids already described seemed to render to a great extent the remaining proteid insoluble in potash water and only insignificant precipitates resulted on neutralizing the extracts. The barley flour also contained a large quantity of gum which rendered the filtration of the alkaline extract very difficult, as this gum dissolved freely in potash water. As the proteids prepared from the barley flour are all so similar to those obtained from wheat flour it is most probable that this seed also contains a considerable quantity of proteid soluble only in dilute alkaline solutions, but, as in the case of rye, the writer was unable to obtain results of any value whatever in regard to it.

Conclusion.

The barley kernel contains:

I. Leucosin coagulating at 52°, which is the same as the albumin found in the wheat and rye kernels. Its composition, as shown by the average of six analyses, is:

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Carbon	52.81
Hydrogen	6.78
Nitrogen	16.62
Sulphur	1.47
Oxygen	22.32
	100.00

This substance forms about 0.3 per cent. of the seed.

II. A small quantity of proteose, the reactions and composition of which could not be definitely ascertained.

III. Edestin, a globulin which is the same as that found in the wheat and rye kernels and in a large number of other seeds. Its composition is approximately shown by the figures given below. Owing to the small amount of this body and the difficulty in preparing it, no perfectly pure preparations were obtained.

Carbon	50.88
Hydrogen	6.65
Nitrogen	18.10
Sulphur, Oxygen	24.37
	100.00

This is the proteid commonly known as vegetable vitellin. It is precipitated from saline solutions by dilution and by dialysis, is not coagulated by heating below 90°, and above that temperature only partially. It is not precipitated by saturating its solutions with sodium chloride, but is thrown down from saline solutions by adding acid.

IV. Hordein, a proteid insoluble in saline solutions, very slightly soluble in pure water and extremely soluble in alcohol of about 75-per cent. This is the barley-proteid described by Ritthausen as mucedin. It has almost exactly the same physical and chemical properties as gliadin obtained from wheat and rye kernels but a different composition.

Carbon	54.29
Hydrogen	6.80
Nitrogen	17.21
Sulphur	0.83
Oxygen	20.87
	100.00

About 4.0 per cent. of the seed consists of this substance.

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V. After extracting the barley flour with salt solution and with alcohol the residue still contained 42 per cent. of the total nitrogen, corresponding to proteid matter equal to about 4.5 per cent. of the flour. It was not possible to extract more than a very small amount of this residual proteid with dilute potash water, as the treatment for removal of the other proteids rendered it insoluble, if it were not so already.

VI. The barley flour contained 1.83 per cent. of nitrogen and, if it is assumed that this all belonged to proteid matter with 17 per cent. of nitrogen, the flour would contain 10.75 per cent. of proteids. The barley accordingly contained about 4.5 per cent. of insoluble proteid, 4.0 per cent. of hordein soluble in dilute alcohol, 0.30 per cent. albumin and 1.95 per cent. of globulin and proteose.

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THE CHEMICAL NATURE OF DIASTASE.

By THOMAS B. OSBORNE.

Few substances are of more importance or of more interest than the enzymes or unorganized ferments, yet our knowledge relating to these bodies is almost wholly confined to the products of their activity and the conditions under which this is manifested. Although the existence of these ferments was recognized early in the present century, our information in respect to their true nature is exceedingly limited and unsatisfactory. It was for a long time supposed that the active substance causing a fermentative change is a soluble proteid, and the power of inducing such change seems by many to have been ascribed to soluble proteid matter in general. Later, this power was thought to be restricted to special forms of proteid, but no sufficient evidence was brought forward. Of late years investigators have undertaken to isolate ferments and prepare them in a state of purity. The results of these attempts have led to very conflicting conclusions respecting the character of these bodies. Some of the so-called pure preparations of ferments have had the properties of the proteids, and have more or less agreed with them in composition, while others have differed widely from the proteids in both respects.

It still seems to be the opinion of many that the enzymes are in fact true proteids and that the ferments thus far supposed to be obtained in a state of purity were simply somewhat contaminated with other substances. This opinion is based on the fact that all those changes which are ascribed to the action of enzymes occur only in solutions which contain proteid matter, and that the activity of the ferment is greatly influenced by conditions known to have a pronounced action on proteids, such as heat, the presence of acids and alkalies, salts of the heavy metals, etc.

The first discovered and one of the most carefully studied of these ferments is diastase. The practical application of the action of diastase in the manufacture of alcohol and of malt liquors has given rise to careful and extended studies of the conditions affecting the activity of this ferment, and the result of these studies has led some to the opinion that the active substance is the albumin present in the malt extracts. The conversion of

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starch into maltose and dextrin by diastase increases in rate and extent as the temperature of the solution is raised, until the heat reaches the point at which the albumin begins to coagulate. The ferment then begins to lose power, and, when the heat is sufficient to completely coagulate the albumin, its amylolytic action ceases entirely. In 1883, C. Lintner, Jr., showed that the diastatic power of fifteen different samples of malt was very nearly proportional to the amount of coagulable albumin which they contained. In 1886, however, C. J. Lintner prepared diastase in, as he supposed, a state of purity, and came to the conclusion that the results of his analysis of diastase indicate that, in the ferments, we have a special class of proteid substances. The composition of Lintner's purest diastase differed much from that of the proteids, since it contained only two-thirds as much nitrogen and also less carbon. His diastase furthermore, failed to give the reaction with cupric sulphate and potassic hydrate which is characteristic of proteid matter. These results of Lintner's threw much doubt on the hypothesis that the vegetable albumin is identical with diastase.

In my investigations of the proteids of wheat, rye and barley, I found in all these grains the same albumin and was impressed with the close relation between the temperature at which this albumin coagulates and the temperature at which diastase begins to lose its activity. The aqueous extracts of these seeds, as is well known, possess considerable diastatic power, and it seemed to be more than probable that this was due to the albumin. I accordingly undertook an investigation of this subject, and I now offer the results thus far obtained, which are preliminary to a more extended study.

The usual method of preparing vegetable enzymes is to treat the aqueous or glycerin extract containing them with alcohol as long as a precipitate, having fermentative power appears, to purify this by repeated precipitation from its solution in water, by means of alcohol, and finally to subject the aqueous solution to dialysis to remove salts. This method is wholly unsuited to yield pure preparations, because the precipitate produced by alcohol contains not only a large amount of carbohydrates and salts, but also nearly all of the various forms of proteid matter present in the extract. Lintner employed this method, and there can be no doubt that he obtained a mixture of proteids with other substances which defied all attempts at further separation.

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The most rational method (hitherto very little used) is first to separate the proteids from the carbohydrates and other soluble substances by saturating the extract with ammonium sulphate, thereby precipitating the ferment and proteids together, next to remove the proteid existing as globulin, by dialysis, and then, if possible, to separate the albumin and proteoses by fractional precipitation with alcohol. In following this method, a measured quantity of malt extract was saturated with ammonium sulphate, the precipitated proteid matter was filtered out, dissolved in water, and the clear filtered solution made up to the volume of the original extract. This solution was found to have the same diastatic power as before precipitation, thus showing that ammonium sulphate had not injured the diastase. Throughout my work diastatic power has been measured by Lintner's method, which gives a very ready means of accurately comparing different preparations. This method consists in adding to each of a series of carefully measured volumes of the solution containing definite amounts of the diastatic preparation, ten c. c. of a two per cent. solution of soluble potato starch, and allowing the ferment to act upon the starch for one hour at the ordinary temperature of the room. At the end of this time five c. c. of Fehling's solution are added to each portion and the mixtures are heated for ten minutes in a boiling water bath. After the precipitated cuprous oxide has settled, where too little sugar has been formed to precipitate all the copper, the liquids will be blue; if sugar is in excess they will be yellow. The one colorless liquid that should result gives the measure of diastatic power. Lintner represented the value of his most active preparation by 100, and that of the other preparations by figures stating the amount of each necessary to give a complete reaction with Fehling's solution under the above conditions, in comparison with his most active preparation, of which, under the conditions of the test just described, twelve one-hundredths of a milligram completely reduced the five c. c. of Fehling's solution.

For the sake of comparison I have measured the activity of my preparations by the same standard, so that a preparation whose activity is given as 200 means that six one-hundredths of a milligram sufficed to give a complete reduction.

As Lintner recommended extracting the malt with water containing twenty per cent. of alcohol instead of pure water, since thereby less foreign matter was removed with the proteid, this

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procedure was first tried. Fifteen hundred grams of ground air-dried malt, prepared in the laboratory, were treated with three liters of twenty per cent. alcohol, the extract squeezed out in a press and the residue again treated with another liter of the same dilute alcohol. Three liters of extract were obtained which after being filtered clear were saturated with ammonium sulphate. Owing to the presence of the alcohol much less ammonium sulphate was dissolved than by a water extract, and the proteids were consequently incompletely precipitated. The precipitate obtained was treated with water and a considerable quantity of insoluble matter, consisting mostly of globulin rendered insoluble by contact with the reagents, was filtered out. The solution was saturated with ammonium sulphate, and the precipitate dissolved in water. This clear solution was then dialyzed in water for some days, and after filtering from a slight deposit was dialyzed in alcohol of 0.845 sp. gr. for 48 hours.

As the water passed out of the dialyzer faster than the alcohol entered, the solution became concentrated and a considerable precipitate formed. This was filtered out and washed, first with dilute alcohol and afterwards with absolute alcohol, and dried over sulphuric acid. This preparation, **1**, when thus dried, dissolved in water with the exception of a not inconsiderable residue. When filtered clear, the solution, on heating, gave an abundant coagulum, and after boiling and filtering out the coagulum, the filtrate gave a strong pink color with cupric sulphate and potassic hydrate, showing the presence of proteose. The diastatic power of this preparation, in comparison with Lintner's best was 86, but, as it was afterward found to contain a comparatively small amount of ash, the test was repeated with the addition of a few milligrams of sodium chloride and then found to equal 150.

The composition of preparation **1** was as follows:

PREPARATION **1**.

	Ash-free.
Carbon	52.55
Hydrogen	6.48
Nitrogen	16.41
Sulphur } Oxygen }	24.56
	100.00
Ash	2.29

These figures indicate that this preparation consisted almost wholly of proteid matter, and the reactions proved the presence

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of at least three forms, namely, coagulated proteid, albumin and proteose. This mixture was one and a half times more active than Lintner's most energetic preparation, and contained about six per cent. more nitrogen and one-half as much ash. The composition of the preparation is very similar to that of the coagulated albumin-like body obtained from wheat, rye and barley, and for which I have adopted the name leucosin. As this albumin has been found to have the same composition, whether coagulated by heat or by alcohol, and as most, if not all of the proteids have identical composition (so far as analysis can show), in the soluble and the coagulated states, it seems probable that preparation **1** consisted mostly of coagulated and soluble leucosin together with a little proteose.

The filtrate from this preparation on addition of absolute alcohol, yielded a small precipitate **2** which dissolved wholly in water and gave only a very slight coagulum on heating, but a strong pink biuret reaction, showing it to be mostly proteose. Its diastatic power was only 19.

As above stated, owing to the presence of alcohol, saturation of the original extract of malt with ammonium sulphate, precipitated only a part of the proteids. Accordingly the filtrate from this first precipitation was dialyzed for 24 hours, so as to remove most of the alcohol, and was again saturated with ammonium sulphate. The resulting precipitate was dissolved in water, filtered from a slight residue, and the clear solution dialyzed until nearly all the ammonium sulphate was removed. The dialyzer was then transferred to alcohol and left for 48 hours. The resulting precipitate was then filtered out and treated in the manner before described. After drying, this substance, preparation **3**, like preparation **1**, consisted of insoluble proteid, soluble leucosin and proteose. Its diastatic power was 133, and it had the following composition :

PREPARATION 3.

	Ash-free. I.	II.	Average.
Carbon	52.34	----	52.34
Hydrogen	6.73	----	6.73
Nitrogen	15.90	15.92	15.91
Sulphur } Oxgen }	----	----	25.02
			100.00
Ash			0.82

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The filtrate from this preparation was next treated with a large quantity of absolute alcohol, and the contained proteid completely thrown down. This substance, preparation 4, dissolved entirely in water; its solution yielded but a trace of coagulum on heating, and when boiled and filtered gave a strong proteose reaction. It contained, ash-free, only 12.02 per cent. of nitrogen, and had a diastatic activity of 11.

These results prove: that extraction of the malt with twenty per cent. alcohol is not suited for a subsequent precipitation of the proteids with ammonium sulphate: that otherwise, the method is capable of yielding preparations of diastase of high fermentative power, which to a certain extent, can be separated into fractions containing the different forms of proteid matter: that the fractions including the greatest amount of soluble albumin have the greatest diastatic power: and that a part at least of the proteose is almost if not entirely free from this power.

Another extraction was made on a much larger scale, so that the fractional precipitations might be more numerous, and the fractions examined more closely.

Ten kilograms of malt were exhausted with water and the extract was saturated with pure and neutral ammonium sulphate. The very bulky precipitate was suspended in four liters of water and dialyzed until much of the sulphate had been removed and the precipitated proteid largely dissolved. The solution was then filtered from an insoluble residue consisting mostly of globulin, and the clear filtrate was saturated with ammonium sulphate. The precipitate thus obtained was suspended in 1500 c. c. of water and was dialyzed until nearly all the sulphate had been removed and the precipitate mostly dissolved. The globulin contained in the extract was thus largely separated and, after it had been filtered out, the clear solution was dialyzed into an equal volume of alcohol of .84 sp. gr. After 48 hours the precipitate, number I, which had separated was filtered out and set aside for further examination. The filtrate was again dialyzed into an equal volume of alcohol of 0.84 sp. gr., and after 48 hours another precipitate II obtained. The filtrate was further dialyzed into a rather larger quantity of somewhat stronger alcohol, and precipitate III separated, and by similarly treating the filtrate from this, precipitate IV was obtained, the filtrate from which, on adding a large quantity of absolute alcohol yielded precipitate V. All the proteid in the extract was thus separated. Precipitate I was much

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contaminated with coloring matter, II less so, and III was nearly colorless, as were also IV and V.

The approximate weights of each of these precipitates was as follows: I, 13.0 grams; II, 8.0; III, 6.0; IV, 5.0; and V, 3.0, a total of 35.0 grams.

Precipitate I was treated with water and found to be very largely insoluble. The insoluble matter was filtered out and washed with water, and the clear solution was dialyzed for several days to remove all the salts. No proteid was thus precipitated, and the dialysis was continued in strong alcohol, thereby throwing down all but a trace of proteid. The precipitate, preparation **5**, weighed 2.11 grams. After drying, it dissolved in water with the exception of a small residue, and its solution when slowly heated became turbid at 65° and deposited flocks at 70°. After boiling and filtering out the slight coagulum, the solution gave a strong pink reaction with the biuret test. These tests show the preparation to consist largely of proteose. Its composition was as follows:

PREPARATION 5.

	Ash-free.
Carbon	53.16
Hydrogen	7.03
Nitrogen	16.50
Sulphur	1.50
Oxygen	21.81
	100.00
Ash	0.49

With Lintner's test this preparation showed a diastatic power of 30.

The insoluble residue, remaining after treating precipitate I with water, was thoroughly extracted with ten per cent. sodium chloride solution, what remained insoluble in this menstruum was filtered out and the clear solution dialyzed until free from chlorides. The precipitate thus formed, preparation **6**, weighed 1.20 grams, and after drying was not soluble in water, but dissolved readily and nearly completely in salt solution, having, as was to be expected, the properties of a globulin. This substance had a very slight diastatic power, and its sodium chloride solution when heated slowly became turbid at 60°, a few flocks appearing at 65°, due to a trace of albumin. Its composition was as follows:

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PREPARATION 6.

	Ash-free.
Carbon	53.11
Hydrogen	6.45
Nitrogen	15.78
Sulphur, Oxygen	24.66
	100.00
Ash	0.75

The filtrate from preparation 6 still contained proteid matter which was separated by dialysis in alcohol. Preparation 7 was so obtained, weighing 1.54 grams, having the same properties as 6, and the following similar composition:

PREPARATION 7.

	Ash-free.
Carbon	53.58
Hydrogen	6.70
Nitrogen	15.87
Sulphur, Oxygen	23.85
	100.00
Ash	1.43

After extracting precipitate I with water and salt solution a very considerable part still remained undissolved. This was treated with water to remove all the salt, and then with alcohol, and was dried over sulphuric acid. This preparation, 8, weighed 8 grams and was quite dark in color. It had the properties of an insoluble form of globulin, being dissolved in one-half per cent. sodium carbonate solution and precipitated therefrom by neutralization. Its composition was nearly the same as that of the two last globulin-like preparations and is probably a so-called "albuminate" derived from that substance. The composition of preparation 8 was:

PREPARATION 8.

	Ash-free.
Carbon	53.55
Hydrogen	7.01
Nitrogen	15.72
Sulphur	1.23
Oxygen	22.49
	100.00
Ash	1.09

Precipitate II was treated with water and the solution thus formed was dialyzed in water for several days and then in alcohol

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for 24 hours. A quantity of absolute alcohol was finally added to the contents of the dialyzer, thus completely precipitating the proteid. This preparation after drying was almost wholly soluble in water, and when heated slowly its solution became turbid at 60° and deposited flocks at 66°. The amount of proteid thus coagulated was somewhat greater than was given by preparation **5**, and its diastatic power was likewise greater, being 75. Analysis showed its composition to be as follows:

PREPARATION **9**.

	Ash-free.
Carbon	53.19
Hydrogen	6.71
Nitrogen	16.74
Sulphur	1.38
Oxygen	21.98
	100.00
Ash	0.78

This preparation contained a slight amount of insoluble matter, some albumin and much proteose.

The residue of precipitate II, which was not dissolved by water, was treated with sodium chloride solution and the clear extract dialyzed till free from chlorides, but as no precipitate was produced, the dialyzer was transferred to alcohol when preparation **10** separated, weighing 0.49 gram, and containing, ash-free, 15.18 per cent. of nitrogen. It is probable that this is the same globulin obtained in larger quantity from precipitate I, but less pure. That part of precipitate II which remained undissolved after extracting with water and salt solution, was then washed thoroughly with water and with alcohol, yielding preparation **11**, which weighed 5.0 grams and had the following composition:

PREPARATION **11**.

	Ash-free.
Carbon	53.51
Hydrogen	6.75
Nitrogen	15.76
Sulphur	1.12
Oxygen	22.86
	100.00
Ash	0.66

These figures show that precipitate II contained less globulin and proportionately more leucosin and proteose than precipitate I and it was accordingly found to be more powerfully diastatic.

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Precipitate III was in turn treated with water, the resulting extract filtered clear, dialyzed for several days in water and then in alcohol, absolute alcohol being finally added in quantity to the contents of the dialyzer. The resulting precipitate, preparation **12**, weighed 3.0 grams. It was almost completely soluble in water, and its solution when slowly heated became turbid at 55° and flocculent at 60°. The amount of this coagulum was much greater than that yielded by preparation **9**. The filtrate from the coagulum gave a strong proteose reaction. The diastatic power was 222, indicating the presence of much more diastase than any of the preceding preparations. Its composition was as follows:

PREPARATION 12.

	Ash-free.
Carbon	52.80
Hydrogen	6.96
Nitrogen	16.09
Sulphur	1.45
Oxygen	22.70
	100.00
Ash	0.59

The residue of precipitate III was digested with salt solution, the filtered extract was dialyzed in water till free from chlorides, and then, as no proteids separated, the dialysis was continued in alcohol. Only 0.28 grams of proteid resulted, which, without correction for ash, contained 12.53 per cent. of nitrogen. This was marked preparation **13**, and considered to be impure globulin.

The part of precipitate III still undissolved was washed with water and with alcohol, yielding preparation **14**, which weighed 2.87 grams. This had the following composition:

PREPARATION 14.

	Ash-free.
Carbon	53.25
Hydrogen	7.65
Nitrogen	16.12
Sulphur	1.38
Oxygen	21.60
	100.00
Ash	0.55

This preparation has a somewhat higher nitrogen and lower carbon content than preparations 8 and **11**, which is probably due to its being a mixture of the insoluble form of the globulin with

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some insoluble albumin coagulated by the long contact with alcohol to which it had been subjected. This is to be expected, as precipitate III contained relatively more albumin than precipitates I and II.

Precipitate IV was next treated with water, the solution filtered clear, dialyzed for some days in water, and afterwards transferred to alcohol and the dialysis continued. Absolute alcohol was then added to the contents of the dialyzer, giving preparation **15**, weighing 4 grams. This substance dissolved in water to a nearly clear solution, which when filtered perfectly clear and heated carefully became turbid at 50° and gave a large coagulum at 56°. After heating the solution and filtering off the coagulum, a good reaction for proteose was obtained with the biuret test. This preparation had a diastatic power of 600. As this was a much more powerful ferment than any yet produced, its properties were carefully studied and will be described at length later. When analyzed this substance was found to have the following composition:

PREPARATION 15.

	Ash-free.
Carbon	52.50
Hydrogen	6.72
Nitrogen	16.10
Sulphur	1.90
Oxygen	22.78
	100.00
Ash	0.66

It will be noticed that the sulphur in this preparation is a little higher than in the preceding preparations, which is probably due to its containing some sulphate.

The part of precipitate IV which did not dissolve in water was treated with salt solution, but no globulin was extracted. The residue was then washed with water, giving preparation **16**, which weighed 0.9 gram and had the following composition:

PREPARATION 16.

	Ash-free.
Carbon	53.42
Hydrogen	7.15
Nitrogen	16.65
Sulphur, Oxygen	22.78
	100.00
Ash	0.24

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The composition of this insoluble product shows it to be probably coagulated leucosin.

A portion of precipitate V, when treated with water, was found to dissolve completely. It was therefore washed with absolute alcohol, yielding preparation **17**, which weighed 2.87 grams. The clear solution of this substance when heated became turbid at 50°, and yielded a small coagulum at 58°. Boiled and filtered a strong pink coloration was given with the biuret test, thus showing it to consist mostly of proteose. The diastatic power of this substance was 60, only one-tenth that of preparation **15**. Its composition was:

PREPARATION 17.

	Ash-free.
Carbon	51.21
Hydrogen	6.52
Nitrogen	15.40
Sulphur } Oxygen }	26.87
	100.00
Ash	2.37

The lower nitrogen content of this preparation indicates that the strong alcohol had thrown down, together with the proteids, some non-nitrogenous substances.

Much is to be learned by studying these results which will be of service in future attempts to isolate pure diastase.

In the first place, it is plain that we have in our malt extract a globulin, an albumin and at least one, more probably, two, forms of proteose. I believe the substance soluble in salt solution to be a true globulin, since it so readily assumes an insoluble form, and also because a much larger quantity of the same body was obtained by extracting with ten per cent. salt solution, the malt-residue remaining after the extraction with water. I also think that at least two forms of proteose are present, for the water-soluble portion of precipitate I consisted chiefly of proteose, as did also precipitate V. The amount of proteose diminished from precipitate I to precipitate IV, which contained the least, while precipitate V, which, it will be remembered, was thrown down by adding to the solution a very large amount of absolute alcohol was mainly proteose. A part of the proteose was precipitated by alcohol more readily than the albumin, while another part was less readily precipitated. Beside the albumin, globulin and

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proteoses, we have also to take account of the "albuminate" or insoluble forms of the albumin and globulin. The results of this extraction show that the globulin is rendered insoluble more rapidly than the albumin, so that precipitation with alcohol and solution in water, repeated a few times, may be depended upon to remove the former. Whether repeated fractional precipitation can be employed to completely separate the albumin from the proteoses is not so certain. The albumin is thrown down from the malt-extract by saturation with magnesium sulphate, and it is not unlikely that a complete separation can be accomplished by this reagent. It is, however, not to be forgotten that the diastase may be a substance which when heated to from 50°–60° splits apart into an albumin and a proteose, and that the proteose found in the solutions which have been heated is a decomposition product of the diastase. Kühne's attempts to produce pure trypsin led him to suspect that this ferment is a body which when heated yields a coagulable fraction and a proteose-like substance.

Now that we have some precise knowledge of the associated substances, it seems probable that we may succeed in obtaining diastase nearly if not quite pure, and arrive at a clearer and more positive knowledge of this ferment, and also have a guide in further study of other enzymes, which will lead to a more satisfactory understanding of this whole subject. It is probable that the ferments contained in seeds are much easier to prepare than those of animal origin, since the substances with which they are associated are largely non-proteid and comparatively easy to separate. It is also certain that the amylolytic ferments present an easier problem than the proteolytic, for the products of the activity of the latter are so similar, in their nature, to that which the ferment is supposed to possess, as to make it always a matter of great uncertainty whether the separated enzyme is free from those bodies or not.

As already stated, preparation **15** was a very energetic ferment, and on this account its properties were more fully studied, with the following results:

Dissolved in water this substance gave all the usual proteid reactions, and when heated slowly became turbid at 50° and gave a flocculent coagulum at 56°. This is exactly the temperature of coagulation of the albumin (leucosin) which I have prepared from wheat, rye, barley and malt, with identical composition and properties. The aqueous extracts of these grains have,

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moreover, a strong diastatic action on starch. The amount of coagulable albumin in preparation **15** was determined and found to be 53.2 per cent. of the dry substance.

These facts point strongly to the albumin as being the diastatic substance, yet there are several facts, hard to explain if this is true, which cannot be overlooked. Although in general the diastatic power of my preparations was greater the larger the amount of coagulable albumin they contained, I have never yet been able to establish any numerical relations between the two. In no case have I found any diastatic action with solutions free from albumin. Furthermore, the activity of my preparation **15**, is such as to require a much greater diastatic power for malt than this shows if its coagulable albumin is the enzyme.

A malt extract corresponding to a solution of the diastase in five milligrams of malt had the same diastatic power as 0.02 milligram of preparation **15**. As the preparation contained but a little over 50 per cent. of coagulable albumin, this would correspond to only 0.01 milligram of albumin in the five milligrams of malt, or two-tenths per cent. The amount of albumin in malt is much greater than this, as it is also in wheat, rye and barley, whose diastatic power is greatly inferior to that of malt. It is not probable that the *separated* diastase is more active than that *in the seed*, especially in view of the experiments which follow, comparing the action of malt extract and preparation **15**. The only explanation of this that occurs to me, is that the active diastase is a combination of albumin with some other body, presumably the proteose, which breaks up on heating, yielding coagulated albumin, and that, besides this combined albumin, free albumin is also present, which has no diastatic power, but which is coagulated at the same time. There is no direct evidence, however, that this hypothesis is correct.

Compared with other so-called pure ferments, preparation **15** is very active. At 20° it was in a condition to produce, from soluble starch, over 2000 times its weight of maltose and a further undetermined quantity of dextrin, within one hour. After having been dried over sulphuric acid and kept for six months, its activity was reduced to one-half, but in this condition it produced in 17 hours, at 20°, 10,000 times its weight of maltose besides an unknown quantity of dextrin. At 45° the same quantity of maltose was produced in one hour as at 20°. At 50° much less and at 55° very little maltose was formed. These tests were made by using

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an amount of diastase solution just sufficient to produce enough maltose at 20° to exactly reduce 5 c. c. of Fehling's solution.

Compared with malt extract of the same diastatic strength, as measured by the amount of maltose produced in one hour at 20°, the distilled water solutions of preparation **15** have a less powerful action in liquifying starch paste. Five c. c. of malt extract added to ten c. c. of a starch paste containing 2 per cent. of starch, dissolved the starch completely in eight minutes, while the solution of preparation **15** required thirty-seven minutes.

The malt extract is also more energetic in converting starch completely into bodies giving no color with iodine. Five c. c. of the same malt extract added to ten c. c. of soluble starch solution caused the blue reaction with iodine to disappear in thirteen minutes, while it required thirty-eight minutes to reach the same result with the solution of the separated diastase. When, however, the diastase was dissolved in malt extract, whose enzymes had been previously killed by heating, the difference between the separated diastase and that in the malt extract nearly disappeared.

Two test tubes were each charged with 10 c. c. of starch paste. To one tube was added 5 c. c. of fresh malt extract, and to the other the same amount of boiled and cooled malt extract in which had been dissolved a quantity of preparation **15**, sufficient to make a solution of the same sugar-producing power as the fresh malt extract itself.

The fresh malt extract liquefied the starch in seven minutes, the mixture of preparation **15** and boiled malt extract in fourteen minutes, while thirty-seven minutes were required to produce the same result with a distilled water solution of preparation **15**. In completely converting starch into bodies giving no color with iodine, the solution of preparation **15** in boiled malt extract gave exactly the same result as the fresh malt extract, showing that the difference first noticed was due to the conditions and not to the ferment.

In view of these results, it seems highly probable that diastase is a true proteid, for if we consider the extremely minute quantity of preparation **15** required to produce large amounts of maltose, it is hard to believe that this action is due to some substance adhering to the proteid to the extent of only three or four per cent. at the most. If such were the case it is also remarkable that the enzyme should adhere in so much greater quantity to

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the particular precipitate represented by preparation 15 than to any of the other numerous fractions. If diastase, then, is to be considered as a true proteid, it is evidently either an albumin, a combination of an albumin with a proteose, or a proteose. We have seen that those fractional precipitates which consist largely or wholly of proteose have little or no diastatic action, amylolytic power being manifested most strongly in the fractions containing the most albumin, and least in those containing but little, though not in strict proportion to the amount of the albumin. It is to be concluded that the diastatic enzyme is most closely related to the albumin, named leucosin, and it is not improbable that further careful study will show more clearly what this relation is.

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WORK DONE FOR THE DAIRY COMMISSIONER.

By E. H. JENKINS.

The General Statutes of Connecticut provide that the Dairy Commissioner of this State "may have samples suspected to be imitation butter analyzed at the Connecticut Agricultural Experiment Station, or by any State chemist, and a sworn or affirmed certificate of the analyst shall be *prima facie* evidence of the ingredients," etc.

The statute does not require the Station to make these analyses, neither does it provide for any payment to the Station for the work.

The Station has, however, thus far done all the work required by the Dairy Commissioners gratuitously, as there appeared to be no other way in which the Commissioners could have it satisfactorily performed.

The provision that a chemist's affidavit shall be *prima facie* evidence has been ruled by the courts to be unconstitutional.

The affidavit being really the foundation of the accusation the one who draws it must appear in court. Hence the work done for the Commissioner involves the necessity of appearing at every police court where the cases are first brought and when appealed, at the Superior Court till they are finally disposed of.

This feature of the work is the most expensive, taking much time which cannot well be spared from Station duties. No expert fee can be allowed for it by the courts. The Station therefore receives the usual witness fees; mileage and fifty cents for each appearance!

During the year ending Nov. 1st, 1894, twenty-three samples of butter and five of molasses have been examined and sworn statements returned to the Commissioner. In twelve cases expert evidence has been offered in court.

In no case since the office of Dairy Commissioner was created, has the evidence given by the Station been disputed.

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THE BABCOCK METHOD OF FINDING THE AMOUNT OF BUTTER-FAT IN MILK AND CREAM.

By A. L. Winton and A. W. Ogden.

This method is based on the fact that when milk, cream, skim-milk, and butter-milk are mixed in proper proportions with sulphuric acid of a certain strength the acid dissolves or mixes with all the milk-ingredients except the butter-fat, and the latter is completely separated with suitable apparatus and accurately measured.

The quantity of butter-fat determined by the Babcock method, is the most satisfactory basis of payment for milk or cream. It is used by numerous successful creameries east and west and promises to become almost universally applied.

In Bulletin 106 of this Station. issued in 1891, the attention of Connecticut dairymen was called to this method. To answer inquiries more frequently made of late regarding the way to work the Babcock test, Bulletin 117 was issued in January, 1894. In its preparation full use was made of Bulletin 36, of the Wisconsin Experiment Station, written by Dr. Babcock. The substance of Bulletin 117 is here reproduced with suitable additions.

Directions are first given for weighing and sampling milk and its products. Then follow instructions for preserving samples which cannot be immediately tested, and lastly the method of executing the tests is fully described.

Directions for Weighing.

Milk.—To determine the quantity of butter-fat which a cow produces it is absolutely necessary in the first place to know the quantity of milk which she gives.

Weigh the milk accurately at milking time, which may be conveniently done on a spring balance in a pail which weighs an even number of pounds.* If the milk cannot be weighed, the number of quarts multiplied by 2.15 will give its approximate weight. Thus: 8½ quarts is about (8½ × 2.15 =) 18.3 pounds. *The measuring must be accurate.* Froth is not milk. A quart measure filled to a quarter of an inch of the top is not a quart.

* See page 217.

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An "eight quart" pail may hold considerably less or more than eight quarts.

Skim-milk and Butter-milk.—To learn how complete the skimming has been, or how much butter-fat is lost in butter-milk, it is absolutely necessary to know the weight as well as the per cent. of butter-fat in each. The whole quantity must therefore be thoroughly mixed and weighed.

Cream.—A description of the method used for weighing cream will be found on pages 217 and 220.

Directions for Sampling.

Milk of Single Cows.—Milk that has soured or on which cream has risen and dried, so as to form a clot or skin, cannot be accurately sampled on the farm.

Thoroughly mix the milk, as soon after milking as possible, either by pouring three or four times from one pail to another, or by stirring vigorously with a dipper. To secure an accurate sample, thorough mixing is absolutely essential. Failure to secure a fair sample makes the test worthless or worse than worthless. Immediately after mixing, dip out a sample of about one-half gill or two ounces. From this a sample may be at once measured in the way to be described later for testing, or the whole quantity may be put into a *clean and dry* bottle,* with a preservative when necessary, and kept till used in a cold place where it will not freeze.

Mixed Milk of a Herd..—Into some vessel like a cream carrier, pour all the milk from the pails or cans *one immediately after the other*, and from such a height that the whole quantity is stirred up from the bottom. Then with a cup, dipper or pitcher, *at once* take out about a pint. Stir this thoroughly with a spoon immediately before pouring into the sample bottle, or before measuring the quantity for the Babcock test. If there is no can at hand large enough to hold the whole lot of milk, very accurate sampling is more difficult. Still if the milk is in a number of cans or pails of the same size or shape, and all have the same quantity of milk in them, a fair sample may be got by taking the same quantity of milk, a gill, pint or quart, from each can or pail, after thorough stirring as already described, mixing these samples thoroughly, and then taking a single sample from the mixture.

* Rather than try to use large bottles or those not perfectly clean it is better to buy from a druggist new two-ounce bottles with new corks.

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Skim-Milk and Butter-Milk.—The same course should be followed as with the mixed milk of a herd. The *whole quantity* of the skim-milk or butter-milk should be mixed. The sample must not be taken from a part of it.

Cream.—Cream that is very thick, clotted or soured cannot readily be sampled on the farm. The same is true of centrifugal cream when it is badly frothed; but sweet cream thin enough to pour freely, may be sampled in the same way as whole milk, after pouring it two or three times from one vessel to another. See page 211.

Directions for Preserving Samples.

Composite Samples.—If the samples daily taken from the milk of a cow or herd or from the cream supplied by a creamery patron are poured as soon as drawn into a bottle kept for the purpose and mixed together, this mixture is a "composite sample" and represents the average quality of the milk or cream for the entire period during which daily samples were added to it.

By a test of this composite therefore it is possible to determine the average per cent. of butter-fat in the milk or cream for the whole of this period, which may be one, two or even three weeks.

The daily samples of milk added to the composite must be fairly proportional to the total quantity of milk. Full directions regarding the preparation and preservation of such samples will be found on page 222.

Apparatus for Making the Test.

Test Bottles.—The test bottles used for whole milk (figure 1) have graduations from 0 to 10, each division of the scale representing 0.2 per cent. These bottles can be used also for skim-milk and butter-milk, but a bottle which holds twice as much and has a scale graduated to 0.1 per cent. (shown in figure 2) is preferable for that purpose.

The bottle used for cream testing is described on page 223.

Pipettes.—For whole milk, skim-milk and butter-milk a pipette delivering 17.6 cubic centimeters is used (figure 3). When skim-milk and butter-milk are tested in bottles shown in fig. 2, the pipette is filled twice, that is to say 35.2 c. c. are used for the test. The pipette to be used in testing cream is described on page 223.

Acid Measure.—This is a glass graduate which holds, when filled to the mark, 17.5 c. c. See fig. 4.

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Centrifugal Machine.—Most makers of dairy machinery supply machines suitable for the purpose. The sizes vary from four bottle testers to those carrying fifty or more bottles, those last

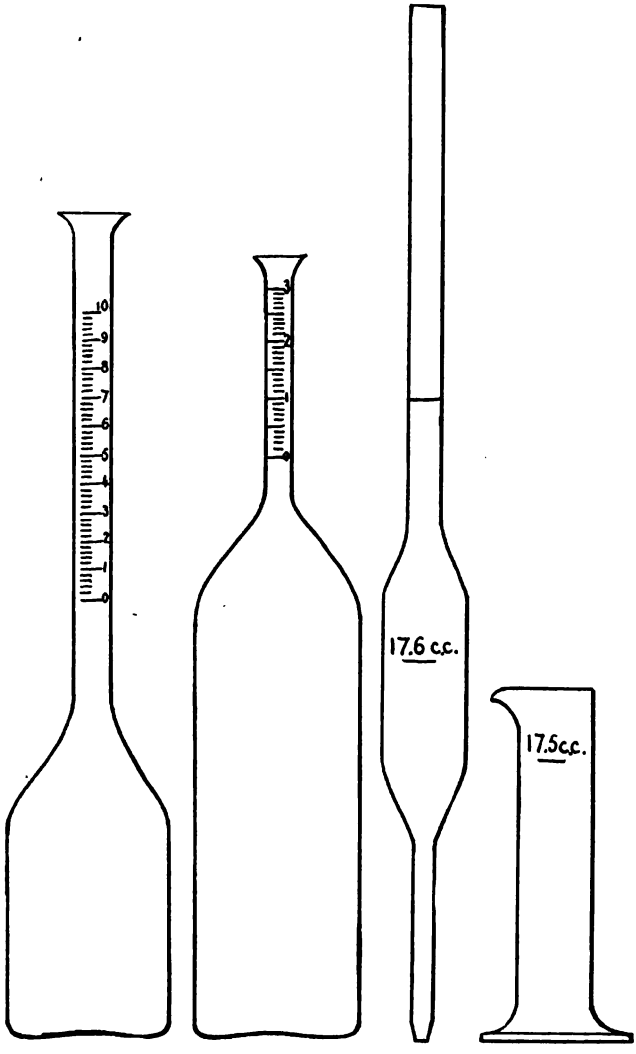

FIG. 1. FIG. 2. FIG. 3. FIG. 4.

being designed for factory use. The wheel to whose circumference the bottles are attached should make from 700 to 1200 revolutions per minute according to its diameter, about 700 revolutions being sufficient for the larger wheels with a diameter of

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about 20 inches, while small 12-inch wheels should run at the rate of about 1200 revolutions per minute.

Commercial Sulphuric Acid (*Oil of Vitriol*).—This should have a specific gravity of 1.82. For further description see page 225.

Directions for Making the Test.

The details of the process of testing are the same for whole milk, skim-milk, butter-milk and cream (except as far as the quantities for testing, and the form of the bottles is concerned, and are fully described on pages 226 to 229.

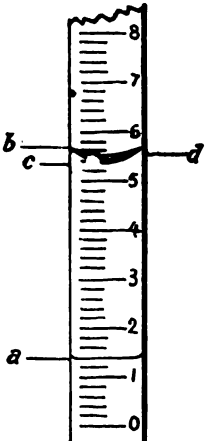
The method of measuring the fat of milk, skim-milk and butter-milk is as follows :

Measuring the fat.—The fat when measured should be warm enough to flow readily, so that the line between the acid liquid and the column of fat will quickly assume a horizontal position when the bottle is removed from the machine.

Any temperature between 110° F. and 150° F. will answer, but the higher temperature is to be preferred. The slight difference in the volume of fat due to this difference in temperature is not sufficient to materially affect results.

To measure the fat, take a bottle from its socket, and holding it in a perpendicular position with the scale on a level with the eye, observe the divisions which mark the highest and the lowest limits of the fat. The difference between these gives the per cent. of fat directly. The reading can easily be taken to half divisions or to one-tenth per cent.

Fig. 6.



The line of division between the fat and the liquid beneath is nearly a straight line and no doubt need arise concerning the reading at this point, but the upper surface of the fat being concave, errors often occur by reading from the wrong place. The reading should be taken at the line where the upper surface of the fat meets the side of the tube and not from surface of fat in the center of the tube nor from the bottom of the dark line caused by the refraction of the curved surface. For instance in Fig. 6 the reading should be taken from *a* to *b* and not to *c* or *d*.

The reading may be made with less liability of error by measuring the length of the column of fat with a pair of dividers, one point of which is placed at the bottom and the other at the upper limit of the fat. The dividers are then removed and one point being placed at the 0 mark of the scale on the bottle used, the other will be at the per cent. of fat in the milk examined.

Sometimes bubbles of air collect at the upper surface of the column of fat and prevent a close reading; in such cases a few drops of strong alcohol (over 90 per cent.) put into the tube on top of the column of fat, will cause the bubbles to disappear and give a sharp

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line between the fat and alcohol for the reading. Whenever alcohol is used for this purpose, the reading should be taken directly after the alcohol is added, as after it has stood for a time, the alcohol partially unites with the fat and increases its volume.

Whenever the fat is not quite clear, more satisfactory results may be obtained by allowing the bottles to stand until the fat has crystallized and then warm them by placing the bottles in hot water, before taking the reading.

If the column of fat is less than about one division as will often happen with skim-milk, butter-milk or whey, it may assume a globular form instead of a uniform layer across the tube; when this occurs the fat can usually be estimated with sufficient accuracy by simple inspection, but in such cases it is better to take a double portion of milk in a large bottle.

The way of reading is illustrated in the figure. The bottom of the clear yellow liquid fat layer is at *a*. The upper surface is represented by *b*, *c*, *d*. The readings are 1.4 and 5.7. The difference, 4.3, is the per cent. of fat in this sample of milk.

To the breeder of dairy stock, to the dairyman who wishes to knows what his cows return for their keep, and to creameries, whether milk gathering or cream gathering, the Babcock tester can be of the greatest service.

THE BABCOCK TEST AS A BASIS FOR PAYMENT IN CREAM-GATHERING CREAMERIES.

By A. L. Winton and A. W. Ogden.

In Bulletin 108, issued by this Station in May, 1891, it was stated that the Babcock test "offers to cream-gathering creameries, a practicable and accurate method of ascertaining the actual quantity of butter-fat which each patron furnishes, so that payments may be based, not on volume of cream supplied, but on *actual butter-fat*, which is the raw material that the creamery manufactures. This is obviously the most satisfactory method of payment."

Since that time, this method has been adopted by several creameries in other States, but nothing of the kind was attempted in Connecticut, until the winter of 1893–4.

Several creamery managers having expressed a desire to introduce a system of payment based on the Babcock test, a practical study of such a system was made early in the year with the

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coöperation of the managers of the Golden Ridge Creamery at Berlin, Conn. The first trials were partly to study the inequalities of the space system and partly to determine by practical experience the forms of apparatus best suited for the Babcock system.

A few weeks experience demonstrated the unfairness of the space system and the practicability of the system based on the Babcock test. At a meeting of the directors of the creamery it was voted to abandon the space system and pay for cream according to the fat which it contained as shown by the Babcock test. On March 1st this change went into effect.

In response to special request, eight other cream-gathering creameries were subsequently visited and the working of the new system illustrated. The plan followed at most of these creameries was to run the two systems side by side for a day thus securing a comparison of results and at the same time giving those interested opportunity to become acquainted with the details of the Babcock system.

The results of these comparative tests are given on pages 236 to 244.

Of these eight creameries, five decided later to adopt the Babcock system and were further assisted by us in carrying out this decision. All of the six creameries which have, with our coöperation, introduced the new system are to-day running successfully on that plan, and others have adopted or are about to adopt the method.

Defects of the Space System of Payment for Cream.

Most of the cream gathered by creameries in this State, is raised by the submerged, deep-setting system, and is paid for by the "space." The "space" is the volume of a cylinder $8\frac{1}{2}$ inches in diameter and $\frac{12}{64}$ of an inch high, and the number of "spaces" in each can of milk is read off before skimming, by means of a strip of glass set in the sides of the can on which the space graduations are marked. The unit for payment is therefore a given volume of cream which, to make the system perfectly equitable, should always contain the same quantity of pure butter-fat.*

* Butter is a mixture of butter-fat—its essential, most abundant and most distinctive ingredient—with more or less water, salt and curd. As the quantities of these several ingredients in butter are quite variable, accuracy and simplicity are best secured by basing all calculations on the quantities of *butter-fat.*

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That the "space" does not always contain the same quantity of butter-fat and that the differences in the quantity of butter-fat in it are often large enough to make this system of payment unfair, are facts of every day observation in creamery practice, which have also been abundantly confirmed by chemical tests. See pages 236 to 244.

Even when the directions of the makers of the apparatus and of the creamery manager are closely followed, the cream raised from milk of one and the same herd, which is fed, handled, and milked as uniformly as possible, will yet show moderate differences in the quantity of butter-fat present, per "space," from day to day.

The time which elapses from the setting to the skimming of the milk, has considerable effect on the number of spaces gathered. For a certain time after setting, the depth of the cream layer and the number of spaces, increase; then follows a period during which the number of spaces slowly decreases, on account of the coalescence of the fat particles, but the per cent. of butter-fat and with it the value of the cream for butter making, is, nevertheless, all the while increasing.

But when the prescribed method of setting is not closely followed by a part of the patrons, differences in the quality of the "space" become so large as to work great injustice to other patrons and generally to those who are producing the most and the best cream. Abundant proof of this will be noticed in the following pages.

Much dissatisfaction comes from the fact that during the winter it is absolutely necessary in some creameries for each patron to measure and record the "spaces" of cream which he raises, so that he may have his cans for use again. The cream-gatherer only makes from two to four trips a week, to get the cream and a copy of the patron's score.

In addition to the defects already noted, it need hardly be said that the dishonest patron may so manipulate his cream as to increase the number of spaces in ways which the cream-gatherer is unlikely to detect.

While the system of setting milk and raising cream now generally in use, if strictly followed, is an excellent one, well suited to our conditions, the system for payment is unsatisfactory because it does not bear a close relation to the actual butter-fat furnished by the several patrons to the creamery.

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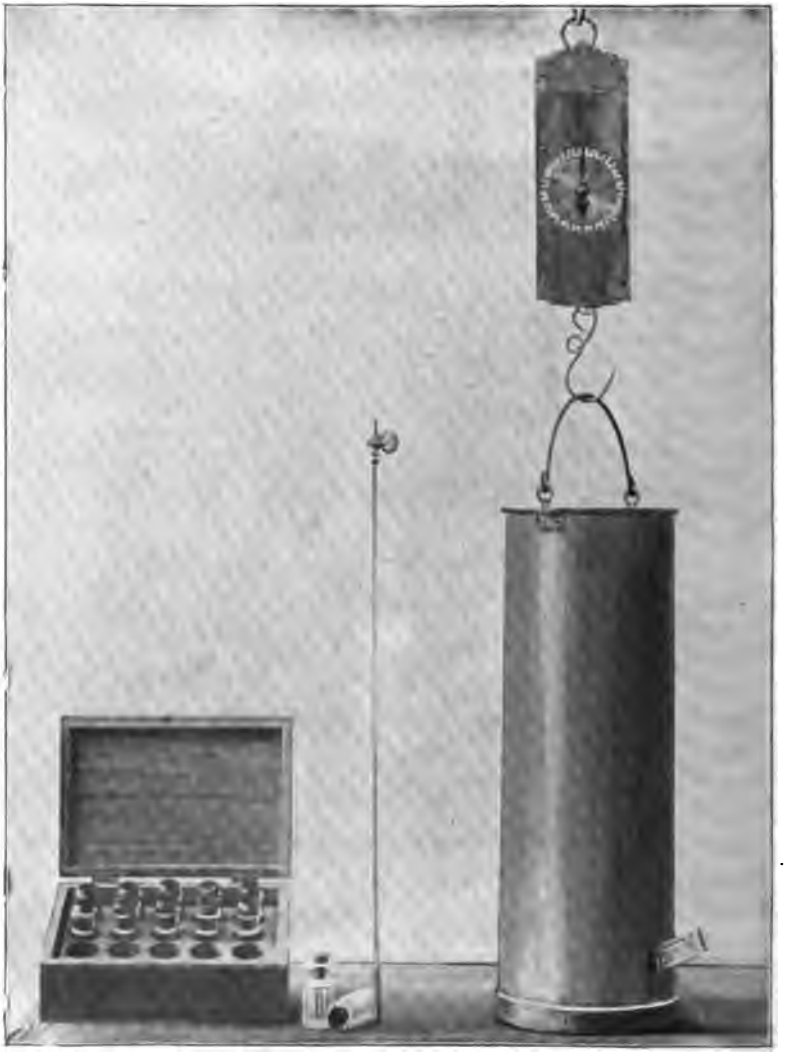

PLATE XIV. Outfit of the Cream Gatherer.

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The Method of Payment According to Amount of Butter-Fat Furnished.

On the following pages is a full description of the system which, with the advice of this Station, has been adopted by a number of Connecticut creameries and which, it is believed, secures to all the patrons fair payment for the cream furnished.

The plan followed is briefly this: The cream, skimmed by each patron, is weighed by the cream-gatherer who also takes a sample accurately representing the entire cream, both as to its quantity and its quality. The samples of each patron's cream gathered from day to day, are mixed and make a "composite sample" which is kept from curdling by a preservative and is finally tested by the Babcock method.

From the total weight of cream gathered and the per cent. of fat in it, the actual weight of butter-fat furnished by each patron is determined and is placed to his credit. Spaces are not taken into account.

APPARATUS FOR SAMPLING AND WEIGHING THE CREAM.

See Plate XIV.

Spring Balance.—A No. 270 Chatillon spring balance, weighing 60 pounds by 2 ounces, is commonly used for weighing the cream. In order to avoid calculation, the index may be set back one-quarter of the circle (equivalent to 5 pounds), so that when the empty pail, which is made to weigh 5 pounds, hangs on the balance, the index stands at 0. See plate XIV.

Prof. Woods of the Storrs Station has devised an improved form of this balance with a loose index, which by means of a set screw, can be adjusted to tare a pail of any weight. A jam screw prevents loosening of the index. Such balances are now made by the Chatillon Spring Balance Co., 85 to 93 Cliff Street, N. Y., and are designated by them as No. 270 M. They can be obtained from all dealers in dairy supplies.

These scales properly used will last for a number of years and may then generally be repaired at a cost of $1.00 to $1.25. They should not be exposed to rain unnecessarily, as the rusting of the mechanism destroys their accuracy.

The pail should not be thrown on the scale hook with a sudden jerk. To draw out the slide and let it snap back suddenly is the worst possible treatment the scale can receive.

The balance may hang on a proper support from the back of

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the gatherer's wagon, at such height that the pail full of cream can be hung on it handily, but will not touch the ground, or the gatherer may take it with him to the room where the patron keeps his cream, and hang it on a hook provided for the purpose. The advantages of the latter plan are, that the weighing, recording and sampling, are done under cover, and a trip from the cart to the patron's score card, which it is necessary to make when the cream is weighed at the cart, is avoided.

Pail for Sampling and Weighing.—This pail should be of cylindrical (not conical) form with a stout bail, and, to aid in pouring, it must either be provided with a handle on the side near the bottom, or have the sides extend an inch or two below the bottom. It may have any diameter from 8 to 12 inches, but the height should be so proportioned to the diameter that it will hold about 40 pounds of cream. When carried in the hand it should clear the ground by several inches. See plate XIV.

Sampling Tube.—This tube, devised by Mr. Ogden, is of stout brass about $\frac{1}{32}$ of an inch thick, and a few inches longer than the weighing pail which is used with it. On the upper end, a small brass stop-cock of the same bore is fastened. It should be nickel plated inside and out to keep the metal smooth and free from corrosion. These tubes may be obtained from less than $\frac{3}{16}$ to over $\frac{1}{4}$ inch bore. The greater the diameter of the weighing pail, the wider should be the bore of the tube. For use with pails 8 inches in diameter, a $\frac{3}{16}$ inch bore sampling tube will serve the purpose but when the pail has a diameter of 9 or more inches a tube with a bore of $\frac{1}{4}$ inch or more should be used. It must be borne in mind that doubling the diameter of the pail, or of the sampling tube, increases the capacity fourfold.

The tube when not in use should be kept in an upright position to permit draining.

Sample Bottles.—Two sets of sample bottles are used:

(1.) *Collecting bottles.*—Small wide-mouthed bottles, holding from one to one and one-half fluid ounces, closed by good corks are suited for carrying the collected samples. Numbers, corresponding to the different patrons, may be burned into the tops of the corks by means of a red hot iron. The bottles themselves are not otherwise marked. These are taken by the cream-gatherer on each trip, to receive the samples that represent every lot of cream collected. See Plate XIV.

The gatherer should be provided with a convenient case, having a compartment for each bottle, and a cover which when closed and fastened, will hold the corks securely in their places.

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(2.) *Composite Sample Bottles.*—Half pint "Lightning" fruit jars, or wide-mouthed bottles of convenient size fitted with corks, are used for this purpose. The bottles should not be much larger than is necessary to hold the largest of the composite samples.

INSTRUCTIONS FOR SAMPLING AND WEIGHING THE CREAM.

Numbering of patrons.—The patrons are distinguished by numbers, and the corks of the sample bottles bear corresponding numbers. To avoid error each patron's number should be posted in a conspicuous place near his creamer.

Skimming.—Patrons are required to draw off their own cream and to keep it protected from dirt and odors, *and at a low temperature.* This saves the time of the cream-gatherer, and puts most of the cans more promptly at the disposal of the patron. If separators are used they are so gauged as to run cream of about the same thickness as Cooley cream, i. e. with not more than 25 per cent., preferably from 18 to 20 per cent., of fat. Pan-set cream, or cream that is frozen or sour cannot be accurately sampled, and is rejected for this, if for no other reason.

Mixing the Cream.—Pour each patron's cream at least twice from one vessel to another. The last pouring must bring it into the weighing pail. *It is absolutely essential that the cream should be thoroughly mixed before sampling. This is the most critical part of the whole operation.* If there is enough cream to fill the weighing pail more than once, each pailful must be carefully mixed and sampled.

The following experiment illustrates the importance of thorough mixing.

A Cooley can full of cream was allowed to stand quiet for 24 hours. Three portions were then taken: the first by dipping from the surface, the second by drawing from the bottom and the third by taking a section through the cream from surface to bottom with the sampling tube.

The remaining cream was poured once into a second can and three portions were taken as before.

After pouring the cream once more, a third sample was drawn with the sampling tube.

Determinations of fat in the several portions gave the following results:—

First: The surface portion of the cream before it was disturbed by pouring contained 28 per cent. of fat, the bottom portion only 5 per cent., or less than $\frac{1}{5}$ as much as the surface.

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Second: After the first pouring, there was a difference of only one and one-quarter per cent. of fat between the surface and bottom portions of cream.

Third: The sample taken with the tube before pouring the cream did not contain within three per cent. as much fat as the whole quantity of cream was known to contain.

Fourth: After pouring once, the per cent. of fat in the sample drawn with the sampling tube was practically the same as that in the sample drawn after the second pouring.

The reason why the sampling tube did not draw a correct sample from the cream which had stood quiet for 24 hours was that the very thick cream on the surface was pushed aside by the tube instead of filling into it, thus making the sample deficient in fat. It follows that it is necessary to mix the cream even when a sampling tube is used.

The per cents. of fat found in the test just described were as follows:—

Fat in Cream which stood for 24 hours.

	Surface.	Bottom.	Sample drawn with sampling tube.
Not mixed.....	28.0	5.0	19.25
Poured once	23.75	22.0	22.50
Poured twice	....	....	22.25

Sampling and Weighing.—Lower the sampling tube *with the cock open*, to the bottom of the weighing pail which holds the mixed cream. When it is filled raise it out of the liquid and allow it to drain for a few seconds. By this means the tube is rinsed with the cream to be sampled and any traces of cream adhering to the tube from previous use are removed. With the cock still open, slowly lower the sampling tube to the bottom of the cream pail. After allowing a moment for the cream to rise in the tube to the same height as in the pail, close the cock and raise the sampler carefully out of the cream. As long as the cock is closed the cream in the tube will not flow out, unless the tube is strongly jarred. Allow the cream adhering to the outside of the tube to drain off for a few seconds, then put the lower end into the collecting bottle which bears the patron's number on its cork and open the cock. The cream will then flow out of the sampler into the bottle, which is afterwards securely corked and put into the cream-gatherer's case. Immediately weigh the cream in the cream pail to the quarter or half pound as may be judged expedient and record the weight.

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If the patron has more than one pailful, repeat with each pailful the operation of sampling and weighing, putting all the samples in one and the same bottle. *Weigh all cream collected, in one and the same sampling pail and draw a sample from each separate portion weighed.*

In case a patron has so little cream that a single portion drawn by the tube from day to day will not be sufficient to make a composite sample large enough for testing, two or more cores may be taken, *but at every gathering the same number.* If two cores are taken to-day, then two must be taken to-morrow and every day until the test is made; if three cores, then three every day.

Operating according to these directions the sample not only represents the quality of the whole amount of cream, but is also proportional to its quantity. If a patron furnishes twice as much cream to-day as he did yesterday, the sample drawn from to-day's cream will also be twice as large as yesterday's and if there is a decided difference in the quality of cream on the two days this method of sampling will make due account of it in the composite sample.

When the whole quantity of cream is very small, less than half a pailful, it is best not to take a sample in the way above described, but putting the sampler in the cream, apply the mouth to the stop cock and suck the sampler full, close the cock and transfer this sample to the collecting bottle.

The size of the sample taken in this way does not correspond to the quantity of cream, but the possible error thus introduced is inconsiderable when the quantity of cream is small and nearly alike from day to day.

If, however, it is desired to be more exact, small lots of cream can be sampled in the way first described, in a pail having a diameter of four inches.

A given quantity of cream in this pail will have four times the depth which it has in the larger one and the sampler will therefore draw a sample four times as large.

Where the gatherer's route is long there has been some trouble during the hottest days of summer with the samples souring or churning during transit. The churning may take place without the sample souring. Such samples should be rejected as it is better to lose a single day's sample occasionally than to render the composite sample unfit for testing. If during hot days the gatherer carries his case of samples in a box with a piece of ice, sour-

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ing and churning can generally be prevented provided the cream has been properly cared for previously by the patron and the gatherer is not on the road more than half a day. Churning can be avoided by filling the collecting bottles full to the cork thus avoiding the agitation which takes place in partially filled bottles. The samples thus obtained are all of the same size and do not represent the quantity of cream. If experience has proved that the cream of the several patrons does not vary greatly in quantity from day to day it is sufficiently accurate to add samples of the same size from day to day to the composite sample. If, however, there is considerable variation a quantity proportional to the weight of cream furnished may be measured out each day in a graduate from each man's sample and added to the corresponding composite sample.

As samples of each patron's cream come in to the creamery the superintendent has opportunity to gain an idea of the quality of the product furnished by each. If a sample is sour or foul smelling when it reaches the creamery it is usually evidence that the patron has been remiss in caring for his cream. We have been told by a creamery manager that the feeding of turnips may also be detected by the odor of the daily samples.

THE COMPOSITE SAMPLE.

Preservative.—Bichromate of potash when added in the proportion of one grain of the salt to two ounces of cream (or milk) will preserve the sample, when kept in a cool place, in a suitable condition for testing for at least two weeks.

Although poisonous, this substance is by no means so violent a poison as corrosive sublimate, which some have recommended, and may be used with comparatively little danger. It gives to the liquid an orange yellow color easily distinguishable from pure cream (or milk) which lessens the danger from its use. Packages containing this material should, however, always be labelled "Poison." The quantity used need not be weighed as the amount may vary considerably without affecting the results, although greatly excessive quantities are to be avoided.

A pistol cartridge shell, of .22-inch calibre, cut to a length of ¼ inch, will hold, when loosely filled, enough of finely powdered bichromate to preserve one-quarter of a pint of cream.* Con-

*A .22-inch calibre shell cut to ¼ inch long holds enough to preserve ¼ pint. A .32-inch calibre shell cut to ¼ inch long holds enough to preserve ¼ pint. A .32-inch calibre shell cut to ¼ inch long holds enough to preserve one pint.

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venient measures can be made by cutting off shells to the proper length with a file and soldering on a piece of wire for a handle.

When beginning a series of tests, place in each composite sample bottle the quantity of powdered bichromate of potash required for keeping one-quarter of a pint of cream. If the quantity at any time amounts to more than this, more bichromate may be added.

Transferring the Samples.—As soon as the collected samples arrive at the creamery, shake each moderately, pour it into the composite sample bottle bearing the corresponding number and allow the collecting bottle to drain for a moment. Cork the composite sample bottle and give it a rotary motion to mix the new cream with that previously collected, as well as with the bichromate. If this is not done, the thick layer which has risen since the last addition of cream, may adhere to the side of the bottle and finally interfere with taking the portion for testing. Keep the samples in a cool place, but do not allow them to freeze. The small collecting bottles and corks should be put into hot water at once, or before the adhering cream dries to them, should be washed, dried and placed in the cases ready for the next collecting trip. Since only the corks are marked, no confusion of bottles can arise.

APPARATUS FOR TESTING CREAM BY THE BABCOCK METHOD.

Test Bottles.—The form of cream bottle devised by Mr. Winton, and described in Bulletin 117 of this Station, is suited for creamery use. (See figure 1, page 224.) It has a wider neck than the bottles used for testing milk. The neck is graduated from 0 to 30 per cent., but the readings can be readily made to a quarter of a per cent.

One of the most convenient ways of numbering the test bottles is to have a ground or etched spot on the neck of the bottle above the graduation, on which the number of the test can be marked with a lead pencil.

The necessary grinding may be done with a sharp wet file.

Pipettes.—The cream is measured in a pipette delivering 18 cubic centimeters. The opening at the lower end should be rather larger than for milk pipettes, so that the cream, which is thicker than milk, will deliver readily. See fig. 2.

Acid Measure.—This is a glass graduate, which holds when filled to the mark, 17.5 cubic centimeters. The labor of measuring

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the acid may be considerably diminished by using the special forms of apparatus devised by Farrington, Patrick and Greiner. See fig 3.

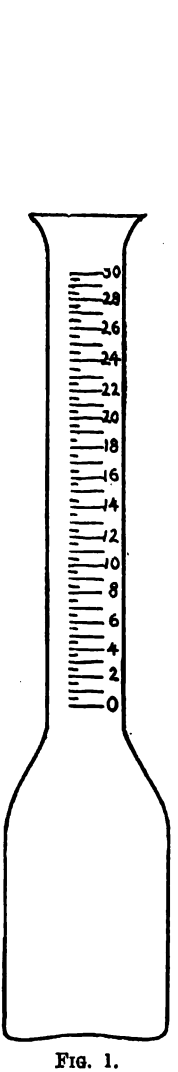

FIG. 1.

FIG. 2.

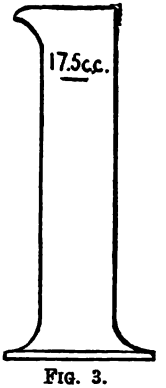

FIG. 3.

Centrifugal Machine.—The so-called steam turbine testers are especially adapted for creamery use. The power is communicated by a jet of steam, playing into pockets attached to the rim

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of the wheel which carries the bottles. By this device the time and labor consumed in operating the hand machines are spared and the more complicated machinery of the power testers is avoided. The escaping steam keeps the contents of the bottles from cooling, and after the last whirling, the fat is at a proper temperature for measuring. The wheel to which the bottles are attached should make, during the test, from 700 to 1200 revolutions per minute, according to its diameter; 700 revolutions being sufficient for the larger wheels with a diameter of about 20 inches, while 12-inch wheels should run at the rate of 1200 revolutions per minute. The machine should have a spindle to which a speed indicator can be applied, and should be tested from time to time to make sure that it is working properly. We have found, in creameries, machines which were running too slowly to do thorough work. In ordering machines it should be specified that they shall be fitted with a spindle for testing speed and that when the machine is loaded with the test bottles the shaft shall make the proper number of revolutions per minute with 30 pounds of steam. Be sure that the steam pipe is large enough to deliver *dry* steam and that while the tester is running, the steam is not used elsewhere in such quantity as to interfere.

Commercial Sulphuric Acid (*Oil of Vitriol*).—This should have a specific gravity of 1.82 to 1.83. If much stronger, the fat will be of a dark color; if weaker, the fat is liable to be contaminated with undissolved curd. It should be purchased of guaranteed strength. The acid should be kept in tightly stoppered bottles, as otherwise it rapidly absorbs moisture from the air and becomes too weak. The stopper should be of either glass or rubber and not of cork, which is rapidly destroyed by the acid. This oil of vitriol is extremely corrosive. It will ruin very quickly, clothing or leather on which it falls and soon makes painful burns if in contact with the skin. If the hands come in contact with it they should be immediately and thoroughly rinsed. Sal-soda or wood ashes will neutralize it and check its corrosive action. The greatest care must be used in handling this acid.

Apparatus for Filling the Test Bottles With Hot Water.—A convenient arrangement for this purpose consists of a four quart pail, the contents of which may be delivered through a piece of small flexible rubber tubing attached to a piece of metal tubing that is soldered on the side of the pail at the bottom. The rubber tubing is about three feet long and provided with a pinch-cock.

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For use the pail is filled with boiling hot water and placed on a support a foot or two above the machine, thus giving the necessary head. By opening and closing the pinch-cock, the hot water may be delivered in the bottles, in proper quantity.

Making the Test.

Tests may be made twice, three times, or four times a month, as is most convenient, since experience has proved that bichromate will keep cream at least two weeks.

The details of the process of testing are best described, substantially, in Dr. Babcock's own words. Certain minor changes are advisable, as the directions here are wholly designed for testing cream.

Temperature of the Cream.—The composite sample bottles should be brought from the cold room into the room where the tests are to be made and allowed to warm to at least 60° F. before testing. The effect of too cold cream is similar to that of too weak acid.

Mixing the Sample.—Shake the bottle until the cream is thoroughly mixed, and of uniform consistency.

Measuring the Cream.—Immediately after mixing, the pipette is filled by placing its lower end in the cream and sucking at the upper end until the cream rises above the mark on the stem; then remove the pipette from the mouth and quickly close the tube at the upper end by firmly pressing the end of the fore-finger to prevent access of air. So long as this is done the cream cannot flow from the pipette. Holding the pipette in a perpendicular position, with the mark on a level with the eye, carefully relieve the pressure of the finger so as to admit air slowly to the space above the cream. In order to more easily control the access of air both the finger and end of the pipette should be dry. When the upper surface of the cream coincides with the mark upon the stem, the pressure should be again applied to stop the flow of cream. Next, place the point of the pipette in the mouth of one of the test bottles, and removing the finger allow the cream to flow into the bottle. After waiting a short time for the pipette to drain, blow into the upper end to expel the cream held in the point. If the pipette is not dry when used it should be filled with the cream to be tested, and this thrown away before taking the test sample.

Persons who have had no experience in the use of the pipette will do well to practice a short time by measuring water into a test bottle before attempting to make a test.

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Adding the Acid.—After the cream has been measured into the test bottle the test may be proceeded with immediately, or the bottles may be left for a day or two without materially changing the results; samples that have remained in the test bottles two or three months and which had commenced to mould before the acid was added, have given the same amount of fat as samples tested immediately after being measured. If the cream has become coagulated, the curd should be broken up by shaking the test bottle before the acid is added. It is advisable, however, that the test be proceeded with immediately after the samples are measured, if possible.

The volume of commercial sulphuric acid required for a test is approximately the same as that of the cream, or 17.5 c. c. for the ordinary test. If too little acid is added, the casein is not all held in solution throughout the test, and an imperfect separation of the fat results. If too much acid is used, the fat itself is attacked. The acid need not be measured with great accuracy, as small variations will not affect the result.

Great care must be taken in handling the acid to avoid getting any of it upon the skin or clothing, as it is very corrosive. If by accident any is spilled upon the hands or clothes, it should be washed off immediately, using plenty of water. A prompt application of ammonia water to clothing upon which acid is spilled may prevent the destruction of the fabric and restore the color.

When all the samples of cream to be tested are measured ready for the test, the acid measure is filled to the 17.5 c. c. mark with sulphuric acid, and from this it is carefully poured into a test bottle containing the cream. The acid being much the heavier sinks directly to the bottom of the test bottle without mixing with the cream that floats upon it. The acid and cream should be *thoroughly mixed* together by gently shaking with a rotary motion. At first there is a precipitation of curd, but this rapidly dissolves. Much heat is evolved by the chemical action and the solution, at first nearly colorless, soon changes to a very dark brown, owing to the charring of the milk sugar.

Whirling the Bottles.—The test bottles containing the mixture of cream and acid should be placed in the machine and whirled directly after the acid is added. An even number of bottles should be whirled at the same time and they should be placed in the wheel in pairs opposite to each other, so that the equilibrium of the apparatus will not be disturbed. When all the test bottles are in the apparatus, the cover is placed upon the jacket and the

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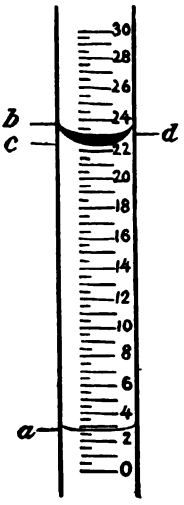
machine turned at the proper speed for about five minutes. The test should never be made without the cover being placed upon the jacket as this not only prevents the cooling of the bottles when they are whirled, but in case of the breakage of bottles, may protect the face and eyes of the operator from injury by pieces of glass or hot acid.

The machine should be frequently tested with the speed indicator to make certain that the bottles are whirled at the required speed. Too slow motion results in imperfect separation of butter-fat.

If a steam turbine is not used, the test bottles should be whirled immediately after adding the oil of vitriol. In case of delay they must be heated to a temperature of about 200° Fahr. before putting them in the machine.

Filling the bottles with hot water.—As soon as the bottles have been sufficiently whirled, they should be filled to the neck with hot water. If practicable, distilled or rain water should be used for the purpose. The bottles are most conveniently filled by help of the apparatus already described; the flow of water can be perfectly controlled by the pinch-cock upon the rubber tube. If only a few tests are to be made, the bottles may be filled with a pipette, or by pouring from a graduate. The cover should then be replaced and the machine turned for about two minutes. Hot water is now added to fill the test bottles nearly to the 28 per cent. mark, and after whirling for about one minute longer the fat is ready for measuring.

Fig. 4.



Measuring the fat.—The fat when measured should still be hot to the touch.

To measure the fat, hold the bottle in a perpendicular position with the scale on a level with the eye, observe the divisions which mark the highest and the lowest limits of the fat. The difference between these gives the per cent. of fat directly.

The line of division between the fat and the liquid beneath is nearly a straight line and no doubt need arise concerning the reading at this point, but the upper surface of the fat being concave, errors often occur by reading from the wrong place. The reading should be taken at the line where the upper surface of the fat meets the side of the tube and not from surface of fat in the center of the tube nor from the bottom of the dark line

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PLATE XV. Creamery Laboratory for Babcock Tests.

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caused by the refraction of the curved surface. For instance in fig 4 the reading should be taken from *a* to *b* and not to *c* or *d*.

The reading may be made with less liability of error by measuring the length of the column of fat with a pair of dividers, one point of which is placed at the bottom and the other at the upper limit of the fat. The dividers are then removed and one point being placed at the 0 mark of the scale on the bottle used, the other will be at the per cent. of fat in the cream examined.

Sometimes bubbles of air collect at the upper surface of the column of fat and prevent a close reading; in such cases a few drops of strong alcohol (over 90 per cent.) put into the tube on top of the column of fat, will cause the bubbles to disappear and give a sharp line between the fat and alcohol for reading. Whenever alcohol is used for this purpose, the reading should be taken directly after the alcohol is added, as after it has stood for a time, the alcohol partially unites with the fat and increases its volume.

Whenever the fat is not quite clear, more satisfactory results may be obtained by allowing the bottles to stand until the fat has solidified and then warm them by placing the bottles in hot water, before taking the reading.

The way of reading is illustrated in the figure. The bottom of the clear yellow liquid fat layer is at *a*. The upper surface is represented by *b*, *c*, *d*. The readings are 2.75 and 23.75. The difference, 21.00, is the per cent. of fat in this sample of cream.

After satisfactory tests have been made on all the samples, the cream that remains in the sample bottles is thrown away.

Cleaning the Test Bottles.—If the fat has solidified by cooling, warm until it is melted. This may be done by replacing the bottles in the machine and turning on the steam, or by running hot water over the bottles from the apparatus already described. Give each bottle a quick motion so as to throw out the fat, then empty out the remainder of the liquid, shaking all the time to loosen the white sediment on the bottom. Fill to the brim with boiling water, and place in the rack to empty and drain. After wiping off the outside with a cloth, the tubes, although not perfectly clean, are free from fat and ready for use again.

The accompanying plate, Plate XV, shows a very convenient arrangement of the testing apparatus made by Mr. B. F. Case, manager of the Canton Creamery, at Canton Center, in this State.

To the right of the picture is a steam turbine apparatus carrying 50 test bottles, provided with a speed indicator. Above it

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hangs a pail from which the hot water is drawn for filling the test bottles after whirling.

On the bench are racks for drying and storing the test bottles and pipettes and in front is a stand to hold the bottles while they are being filled.

At the right of this stand is a convenient apparatus for measuring the oil of vitriol into the test bottles.

At the extreme left is a sink for washing apparatus. The water can be quickly heated from the hose attached to the steam pipe. The cupboards above carry bichromate of potash and any other chemicals and apparatus which are desired.

PLATE XIII.

Plate XIII shows the method of storing the composite samples at the Canton Creamery. The closets, closing in front by doors hinged at the top, which can be securely locked, and communicating at the back with the cold storage room, are fitted with drawers, each devoted to a particular cream-gathering route. Each jar bears the number of one of the patrons and all samples of his cream are poured into it as soon as brought in.

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Book Keeping of the Babcock Test System.

The pounds of cream collected from each patron are recorded from day to day and footed up at the end of the month, exactly as was done with spaces by the space system. The record of the Babcock tests are conveniently kept by themselves in a book or on blanks prepared for the purpose. Once a month the total pounds of cream furnished by each patron, and the average per cent. of fat in it, are posted in the ledger. Fractions of a pound are carried over to the next month and the percentages of fat are given to one place of decimals. The ledger is generally ruled with columns properly headed for names of patrons, numbers of patrons, pounds of cream, pounds of fat, average per cent. of fat, and finally the amount due, as shown below :

January, 1895.

No. of patron.	Name of patron.	Pounds of cream.	Average per cent. of fat.	Pounds of fat.	Payment at 30c per lb. of fat.
1	John Smith	1500	18.9	283.5	$85.05
2	James Jones	147	20.2	29.7	8.91
3	Henry Brown	963	14.0	134.8	40.44

This arrangement is compact and gives opportunity to foot up the total pounds of cream and fat received during the month by the creamery, and the total amount paid the patrons.

In the monthly report for distribution among the patrons details such as are on page 232 may be given.

Records of Five Connecticut Creameries Running on the Babcock Test System.

In the following table is given an abstract from the records of five creameries which have used the Babcock system of payment for from five to ten months, to the entire satisfaction of the creamery managers and nearly all of the patrons.

It will be noticed that while the average composition of the cream of all the patrons does not show very great fluctuations, from 16.9 to 19.8 per cent. of fat, the cream of certain patrons on certain days has contained as little as 9.5 per cent. of butter-fat and of other patrons has contained 30 per cent.

Under this system of payment however both those whose cream is exceptionally poor and those whose cream is exceptionally rich receive their fair share and only their fair share of the payments.

The pounds of cream required to make a pound of butter has varied between 4.18 and 5.02 and has averaged 4.54 lbs.

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The lowest average per cent. of fat, 16.9 was during December at creamery A and it took more pounds of this cream, 5.02, than of any other to make a pound of butter. On the other hand the highest average per cent. of fat, 20.3, obtained during October at creamery D, corresponds with the lowest number of pounds of cream required to make a pound of butter, 4.18.

In general the poorer the cream in fat the more pounds it takes to make a pound of butter and *vice versa*.

The number of pounds of butter-fat in the cream required to make a pound of finished butter varied between .807 and .877 pound and averaged .841 pound.

		Pounds of Cream received.	Pounds of Fat received.	Per cent. of Fat in the Cream.			Pounds of Butter made.	Pounds of Cream to make a Pound of Butter.	Pounds of Fat to make a Pound of Butter.
				Average.	Highest.	Lowest.			
Creamery A.	March	20676	3787.1	18.3	24.7	12.0	4365	4.74	.868
	April	20832	3849.7	18.5	23.0	14.9	4384	*4.59	*.848
	May	27601	4919.8	17.8	25.1	16 9	5323	*4.92	*.877
	June	25757	4927.4	19.2	27.0	16.6	5426	*4.34	*.830
	July	20771	3920.4	18.9	28.0	15.9	4088	*4.30	*.808
	Aug.	19904	3793.6	19.1	30.0	16.6	4084	*4.54	*.865
	Sept.	18148	3421.0	18.8	28.3	14.8	3935	*4.49	*.847
	Oct.	17144	3209.0	18.7	26.4	15.3	3886	4.41	.826
	Nov.	17694	3082.7	17.4	20.4	12.0	3626	4.88	.850
	Dec.	17971	3037.3	16.9	23.3	9.5	3582	5.02	.848
Creamery B.	June	57440	11113.	19.3	24.3	15.0	12841	4.47	.865
	July	45412	8769.	19.3	23.7	15.0	10642	4.27	.824
	Aug.	33077	6416.	19.4	23.8	14.3	7573	4.37	.847
	Sept.	28959	5684.	19.6	24.7	14.0	6571	4.41	.865
	Oct.	31155	6169.	19.8	24.0	15.8	7085	4.40	.871
Creamery C.	July	60190	11222.5	18.6	23.5	9.5	13346	4.51	.841
	Aug.	55568	10142.5	18.3	25.5	12.5	12367	4.49	.820
	Sept.	44453	8355.7	18.8	26.0	12.5	9623	4 62	.868
	Oct.	47005	8861.8	18.8	24.5	11.8	10665	4.41	.831
	Nov.	40399	6946.5	17.2	22.3	12.8	8609	4.69	.807
	Dec.	42665	7280.6	17.1	21.5	10.0	8804	4.85	.827
Creamery D.	Aug.	53938	10380.9	19.2	26 5	15.3	12100	4.46	.858
	Sept.	50161	9684.2	19.3	25.6	15.4	11398	4.40	.850
	Oct.	53022	10770.9	20.3	25.3	14.6	12692	4.18	.849
	Nov.	48890	9396.4	19.2	24.1	12.8	11244	4.35	.836
	Dec.	50365	9740.3	19.3	24.5	10.2	11569	4.35	.842
Creamery E.	Aug.	55029	9430.8	17.1	21.8	12.2	11191	4.92	.843
	Sept.	45633	8018.7	17.6	24.1	14.0	9884	4.62	.811
	Oct.	54730	9926.9	18.1	23.2	13.2	12204	4.48	.813
	Nov.	46668	8201.0	17.6	23.0	14.1	9953	4.69	.824
	Dec.	51646	8991.0	17.4	21.2	13.5	10923	4.73	.823

* After allowing for cream sold.

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Comparison of the Space System and the Babcock System of Payment at Six Creameries.

The comparisons of the two systems here given, were made at the request of the Superintendent or the President of each of the respective creameries. The six creameries used the Cooley system exclusively. Creameries Nos. 1 and 2, allow the patrons during the winter time to do the skimming themselves every other day, or in some cases oftener. At creameries Nos. 3 and 5, the skimming and the counting of spaces is all done by the cream-gatherers, except on Sundays when it is done by the patrons. The patrons of creameries Nos. 4 and 6, do all of the skimming and count their own spaces.

At the creameries where tests were made of a single gathering, a representative of the Station went with the cream-gatherer over his route, witnessed the skimming (when done by the cream-gatherer), and weighed and sampled the cream. The samples were tested by the Station agent at the creamery. In the week's trial at creamery No. 4, the composite system as here described was followed, all the work except the testing being done by the creamery. Details of the tests are given in tables on pages 236 to 244. To facilitate their study, the following explanations are given :

The first column gives the numbers which represent the individual patrons.

Spaces of Cream.—The second column gives the spaces credited to each, which is the basis of payment by the space system.

Pounds of Cream and per cent. of Fat in the Cream.—The third and fourth columns,—pounds of cream and per cent. of butter-fat in the cream,—furnished the data for calculating the quantity of butter-fat to be credited to each patron.

It should be noticed that, from the number of spaces and the total weight of "cream" given in the tables, it is not possible to calculate the average weight of a space accurately, because some cream-gatherers or patrons "draw closer" than others, that is, draw off more of the skim-milk from the cream, after measuring the spaces.

In any case some skim-milk is gathered with the cream, and in some cases much more than in others. Again, if the gatherer draws equally "close" from each can, still a larger proportion of skim-milk will go with the cream from a can which is half full than from one which is full.

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The number of spaces of cream of course is not changed, however much skim-milk is poured with it into the cream carrier. Nor on the other hand, is the quantity of butter-fat, credited to the patron by the Babcock System, made either larger or smaller by the amount of skim-milk that is weighed with the cream, for the more skim-milk that is added, the lower will be the per cent. of butter-fat shown by the test.

For instance, suppose a patron has 50 pounds of cream which would test 25 per cent. butter-fat, and hence would credit him with 12½ pounds of butter-fat, and suppose he mixes with it 25 pounds of skim-milk so that the cream-gatherer credits him with 75 pounds of cream instead of fifty. He gains nothing, for the Babcock test will only show 16.7 per cent. of fat in this mixture, which is equivalent to 12½ pounds of fat, the same that would be credited from 50 pounds of rich cream.

Per cent. of Fat in the Cream.—It follows from the explanation just given that the per cent. of fat in the total quantity of cream weighed is *of itself* no accurate index of the relative value to the creamery of each patron's cream.

The gatherer may have skimmed one patron's cream much closer than another's, that is, he may have taken with the cream in one case more skim-milk than in another.

Pounds of Fat in the Cream.—The fifth column (calculated from the two preceding columns), is the basis of payment by the Babcock System. It is not butter but butter-fat, the essential ingredient of butter.*

The other columns of the table are those which deserve the careful study of every manager and patron of a cream-gathering creamery, for they furnish a comparison of the two systems, and show moreover just what is the state of things in the present creamery practice of Connecticut.

Pounds of Fat in 100 "Spaces" of Cream.—This column shows the relative value of the "spaces" taken from the different patrons. Notice in Table I, for example, that while 100 "spaces" of cream from Patrons Nos. 5, 8, 18 and 19 furnish to the creamery 15 pounds or more of pure butter-fat, 100 spaces of cream from Patrons Nos. 12, 15 and 21 supply not more than 11½ pounds.

* Butter is a mixture of some 80 to 90 per cent. of pure butter-fat with variable quantities of water, salt and curd.

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Spaces of Cream required to make a Pound of Average Butter.—This column expresses in a more popular, but less accurate way, the facts given in the preceding column. Butter in each case is assumed to contain 85 per cent. of butter-fat.

Referring again to Table I, there is seen abundant illustration of the trouble which is spoken of at every dairymen's meeting. Patrons 5, 8, 18 and 19 furnished cream which required less than 6 spaces to make a pound of butter, while 7¼ to 8 spaces of the cream from Patrons 12, 15 and 21 were required to make a pound of butter.

The next two columns show *the Payment for the Cream by the Space System* at 4 cents per space, and *Payment for the Cream by the Babcock Test System* at 28+cents per pound of butter-fat.

The price per pound of fat given, was obtained by dividing the sum of the amounts paid each patron by the total number of pounds of fat from his cream. The number of pounds of fat in each patron's cream was multiplied by this price per pound, thus giving the price paid for his cream. The columns which give the cost of the cream by the two systems, both foot up to the same amount in dollars and cents.

These columns give the amounts each man would receive if the same total amount of money was distributed by the two systems.

Percentage difference.—In the last column, the difference in the payment by the two systems, is given in per cents. Those with + sign would receive more by the test system; those with the — sign less. Supposing, for example, the percentage difference for a patron is + 10, then that patron would receive by the Babcock test system $110.00, where he gets by the space system $100.00, but if — 10, then he would receive only $90.00 by the Babcock test system when by the space system he would receive $100.

In this connection should be mentioned the fact that the purchase of a Babcock tester and the drawing of samples of cream in the presence of patrons has in some cases made a very noticeable change in the quality and quantity of cream furnished.

The superintendent of one of our creameries reports that, during the week immediately following the taking of samples for testing at the creamery, the number of spaces of cream charged to the creamery notably diminished, but at the same time the output of butter increased. The Babcock test, before its adoption as a basis for payment, had paid for itself in this way.

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Comparison of the Space and Babcock Test Systems for One Gathering.

Creamery No. 1, Feb. 15 and 16, 1894.

Number of Patron.		Spaces of Cream.	Pounds of Cream.	Per cent. of Fat in the Cream.	Pounds of Fat in the Cream.	Pounds of Fat in 100 Spaces of Cream.	Number of Spaces to make a pound of average Butter. (85 per cent. Butter-fat.)	Value of the Cream by the Space System @ 4 cts. per Space.	Value of the Cream by the Babcock Test System @ 29.88 cts. per Pound of Fat.	Payment by the Babcock Test System would give more (+) or less (—) than by the Space System in per cent.
1†		46	31.00	20.50	6.36	13.8	6.15	$1.84	$1.90	+ 3.3
2†		46	32.00	20.25	6.48	14.1	6.03	1.84	1.94	+ 5.4
3†		93	61.00	22.50	13.72	14.8	5.76	3.72	4.10	+10.2
4†		32	21.50	21.75	4.68	14.6	5.81	1.28	1.40	+ 9.4
5†		46	31.25	22.50	7.03	15.3	5.55	1.84	2.11	+14.7
6†		34	22.25	20.50	4.56	13.4	6.34	1.36	1.37	+ .8
7†		53	35.50	19.25	6.83	12.9	6.60	2.12	2.05	— 3.3
8†		40	27.75	22.00	6.11	15.3	5.56	1.60	1.83	+14.4
9	*	42	29.00	19.75	5.73	13.7	6.23	1.68	1.72	+ 2.4
	†	42	31.75	17.50	5.57	13.3	6.41	1.68	1.67	— .6
10	*	30	23.75	17.25	4.10	13.7	6.22	1.20	1.23	+ 2.5
	†	29	21.00	17.50	3.68	12.7	6.69	1.16	1.10	— 5.2
11	*	48	36.00	18.00	6.48	13.5	6.28	1.92	1.94	+ 1.0
	†	46	35.75	17.50	6.26	13.6	6.24	1.84	1.87	+ 1.6
12	*	----	----	----	----	----	----	----	----	----
	†	15	12.75	12.50	1.59	10.6	8.02	.60	.48	—20.0
13	*	37	26.00	17.50	4.55	12.3	6.91	1.48	1 36	— 8.1
	†	36	27.50	18.00	4.95	13.7	6.18	1.44	1.48	+ 2.8
14	*	27	21.50	16.50	3.56	13.2	6.45	1.08	1.07	— .9
	†	26	21.75	17.00	3.70	14.2	5.97	1.04	1.11	+ 6.7
15	*	40	28.50	16.00	4.56	11.4	7.46	1.60	1.37	—14.4
	†	39	27.75	17.00	4.72	12.1	7.03	1.56	1.41	— 9.6
16	*	19	14.50	16.75	2.43	12.8	6.65	.76	.73	— 3.8
	†	18	14.75	17.00	2.51	13.9	6.10	.72	.75	+ 4.1
17	*	22	16 00	17.00	2.72	12.3	6.88	.88	.81	— 8.0
	†	24	17.75	16.25	2.88	12.0	7.08	.96	.86	—10.4
18	*	25	16.00	18.75	3.00	12.0	7.07	1.00	.90	—10.0
	†	21	17 00	18.50	3.15	15.0	5.67	.84	.94	+11.9
19	*	14	11.00	18.00	1.98	14.1	6.01	.56	.59	+ 5.4
	†	15	14.00	17.80	2.49	16.6	5.12	.60	.74	+23.3
20	*	37	28.00	18.30	5.12	13.8	6.14	1.48	1.53	+ 3.4
	†	36	26.50	18.80	4.98	13.8	6.14	1.44	1.49	+ 3.5
21	*	69	52.00	15.50	8.06	11.7	7.27	2.76	2.41	—12.7
	†	70	54.00	15.00	8.10	11.5	7.35	2.80	2.42	—13.6
Total		1217			162.64			$48.68	$48.68	

* Skimmed and spaces counted by patron.

† Skimmed and spaces counted by cream-gatherer.

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Comparison of the Space and Babcock Test Systems for One Gathering.

Creamery No. 2, Feb. 21, 1894.

Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per cent. of Fat in the Cream.	Pounds of Fat in the Cream.	Pounds of Fat in 100 Spaces of Cream.	Number of Spaces to make a pound of average Butter.	Value of the Cream by the Space System (@ 4 cts. per Space.	Value of the Cream by the Babcock Test System at 29.46 cts. per Pound of Fat.	Payment by the Babcock Test System would give more (+) or less (−) than by the Space System in per cent.
1	18	13.25	15.75	2.09	11.6	7.32	$ .72	$ .62	−13.9
2	30	23 50	19.00	4.47	14.9	5.70	1.20	1.33	+10.8
3	90	64.75	19.00	12.30	13.7	6.21	3.60	3.65	+ 1.4
4	18	15.00	12.50	1.88	10.4	8.14	.72	.56	−22.2
5	22	16.50	15.50	2 56	11.6	7.30	.88	.76	−13.6
6	36	21.75	23.00	5.00	13.9	6.12	1.44	1.48	+ 2.8
7	17	12.75	19.25	2.45	14.4	5.87	.68	.73	+ 7.4
8	77	57.00	21.00	11.97	15.5	5.47	3.08	3.55	+15.2
9	18	15.25	12.75	1.94	10.8	7.88	.72	.58	−19.4
10	59	45.00	17.25	7.76	13.1	6.46	2.36	2.30	− 2.5
11	21	19.75	18.00	3.56	17.0	5.01	.84	1.06	+26.2
12	52	41.50	16.00	6.64	12.8	6.66	2.08	1.97	− 5.3
13	68	58.25	18.75	10.92	16.1	5.29	2.72	3.24	+19.1
14	15	17.50	12.50	2.18	14.5	5.85	.60	.65	+ 8.0
15	109	84.75	18.75	15.89	14.6	5.83	4.36	4.72	+ 8.2
16	53	46.50	19.00	8.37	15.8	5.37	2.12	2 48	+17.0
17	47	39.75	16.00	6.36	13.5	6.28	1.88	1.89	+ .5
18	34	25.00	17.00	4.25	12.5	6.80	1.36	1.26	− 7.3
19	161	135.50	14.00	18.97	11.8	7.22	6.44	5.62	−12.7
20	9	10.00	13.50	1.35	15.0	5.67	.36	.40	+11.1
21	16	17.00	11.50	1.96	12.2	6.97	.64	.58	− 9.4
22	38	28.50	16.75	4.77	12.5	6.77	1.52	1.41	− 7.2
23	49	37.50	17.00	6.38	13.0	6.53	1.96	1.89	− 3.5
24	35	27.00	16.75	4.52	12.9	6.58	1.40	1.34	− 4.3
25	8	8.00	7.25	.58	7.2	11.72	.32	.17	−46.9
26	47	33.00	15.25	5.03	10.7	7.94	1.88	1.49	−20.8
27	49	37.75	16.75	6.32	12.9	6.60	1.96	1.87	− 3.5
28	25	20.00	13.50	2.70	10.8	7.87	1.00	.80	−20.0
29	21	16.75	13.00	2.18	10.4	8.20	.84	.64	−23.8
30	27	21.75	18.75	4.08	15.1	5.62	1.08	1.21	+12.0
31	95	48.00	17.00	8.16	12.5	6.77	2.60	2.42	− 6.9
32	109	80.75	19.25	15.55	14.2	5.96	4.36	4.61	+ 5.7
34	160	124.75	18.50	23.08	14.4	5.90	6.40	6.84	+ 6.9
Total	**1603**			**216.22**			**$64.12**	**$64.12**	

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Comparison of the Space and Babcock Test Systems for One Gathering.

Creamery No. 3, Route A, Feb. 22, 1894.

Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per cent. of Fat in the Cream	Pounds of Fat in the Cream.	Pounds of Fat in 100 Spaces of Cream.	Number of Spaces to make a pound of average Butter.	Value of the Cream by the Space System @ 4 cts. per Space.	Value of the Cream by the Babcock Test System @ 28.84 cts. per Pound of Fat.	Payment by the Babcock Test System would give more (+) or less (−) than by the Space System in per cent.
20	73	59.00	12.75	7.52	10.3	8.25	$2.92	$2.18	−25.3
21	13	11.50	17.50	2.01	15 5	5.50	.52	.58	+11.5
22	48	39.75	18.00	7.16	14.9	5.70	1.92	2.07	+ 7.8
23	34	29.00	15.00	4.35	12.8	6.64	1.36	1.26	− 7.4
24	16	13.75	15.25	2.10	13.1	6.48	.64	.61	− 4.7
25	50	40.00	18.75	7.50	15.0	5.67	2.00	2.17	+ 8.5
26	29	23.25	18.25	4.24	14.6	5.80	1.16	1.23	+ 6.0
27	24	18.25	18.50	3.38	14.1	6.03	.96	.98	+ 2.1
28	7	6.00	18.50	1.11	15.9	5.36	.28	.32	+14.3
29	36	28.50	17.00	4.85	13.5	6.31	1.44	1.40	− 2.8
30	32	24.25	19.00	4.61	14.4	5.90	1.28	1.34	+ 4.7
31	18	13.50	19.50	2.63	14.6	5.81	.72	.76	+ 5.5
32	37	26.25	20.00	5.25	14.2	5.99	1.48	1.52	+ 2.7
33	30	24.50	18.50	4.53	15.1	5.63	1.20	1.31	+ 9.1
34	28	22.25	17.50	3.89	13.9	6.12	1.12	1.13	+ 0.9
35	34	26.00	16.00	4.16	12.2	6.94	1.36	1.20	−11.8
36	33	25.00	17.25	4.31	13.1	6.50	1.32	1.25	− 5.3
37	16	15.25	17.25	2.63	16.4	5.17	.64	.76	+18.8
38	32	23.50	19.75	4.64	14.5	5.86	1.28	1.34	+ 4.7
39	23	18.00	18.25	3.29	14.3	5.94	.92	.95	+ 3.3
40	22	18.00	18.25	3.29	15.0	5.68	.88	.95	+ 7.9
41	19	15.75	17.50	2.76	14.5	5.85	.76	.80	+ 5.3
42	21	15.25	18.75	2.86	13.6	6.26	.84	.83	− 1.2
43	98	78.25	18.50	14.48	14.8	5.75	3.92	4.19	+ 6.9
44	8	6.75	16.50	1-11	13.9	6.13	.32	.32	0.0
45	64	48.00	18.50	8.88	13.9	6.13	2.56	2.57	+ 0.4
46	74	54.50	17.00	9.27	12.5	6.79	2.96	2.68	− 9.5
47	26	19.75	19.25	3.80	14.6	5.82	1.04	1.10	+ 5.8
Total	945			130.61			$37.80	$37.80	

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Comparison of the Space and Babcock Test Systems for One Gathering.

Creamery No. 3, Route B, Feb. 22, 1894.

Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per cent. of Fat in the Cream.	Pounds of Fat in the Cream.	Pounds of Fat in 100 Spaces of Cream.	Number of Spaces to make a Pound of average Butter.	Value of the Cream by the Space System @ 4 cts. per Space.	Value of the Cream by the Babcock Test System @ 28.16/100 cts. per pound of Fat.	Payment by the Babcock Test System would give more (+) or less (−) than by the Space System in per cent.
1	21	15.50	17.75	2.75	13.1	6.49	$ .84	$ .77	− 8.3
2	98	75.00	17.25	12.94	13.2	6.44	3.92	3.64	− 7.1
3	87	71.25	16.50	11.76	13.5	6.29	3.48	3.31	− 4.9
4	29	23.50	16.00	3.76	13.0	6.55	1.16	1.06	− 8.6
5	19	15.25	15.75	2.40	12.6	6.71	.76	.68	−10.5
6	19	11.50	24.00	2.76	14.5	5.85	.76	.78	+ 2.6
7	22	15.75	19.75	3.11	14.1	6.01	.88	.88	0.0
8	6	6.00	18.00	1.08	18.0	4.72	.24	.30	+25.0
9	7	6.50	14.00	.91	13.0	6.53	.28	.26	− 7.1
10	24	21.00	18.75	3.94	16.3	5.18	.96	1.11	+15.6
11	29	21.00	16.75	3.52	12.1	7.00	1.16	.99	−14.7
12	42	28.25	24.25	6.85	16.3	5.22	1.68	1.93	+14.9
13	10	9.00	18.50	1 67	16.7	5.10	.40	.47	+17.5
14	18	14.25	18.25	2.60	14.4	5.88	.72	.73	+ 1.4
15	38	30.00	20.00	6.00	15.8	5.38	1.52	1.69	+11.2
16	12	10.50	18.25	1.92	16.0	5.31	.48	.54	+12.5
17	25	19.00	19.25	3.66	14.6	5.80	1.00	1.03	+ 3.0
18	36	26.25	19.50	5.12	14.2	5.98	1.44	1.44	0.0
19	22	16.00	21.00	3.36	15.3	5.57	.88	.95	+ 8.0
Total	564			80.11			$22.56	$22.56	

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Comparison of the Space and Babcock Test Systems for One Gathering.*

Creamery No. 4, Feb. 2, 1894.

Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per cent. of Fat in the Cream.	Pounds of Fat in the Cream.	Pounds of Fat in 100 Spaces of Cream.	Number of Spaces to make a Pound of average Butter.	Value of the Cream by the Space System @ 4 cts. per Space.	Value of the Cream by the Babcock Test System @ 30.88 cts. per Pound of Fat.	Payment by the Babcock Test System would give more (+) or less (−) than by the Space System in per cent.
1	28	20.7	15.75	3.27	11.7	7.28	$1.12	$1.01	− 9.9
2	55	39.8	17.50	6.96	12.6	6.72	2.20	2.16	− 1.8
3	108	80.5	17.50	14.09	13.0	6.51	4.32	4.36	+ .9
4	115	93.6	17.50	16.38	14.2	5.97	4.60	5.08	+10.4
5	53	41.0	17.50	7.18	13.5	6.27	2.12	2.22	+ 4.7
6	69	55.8	15.50	8.64	12.5	6.79	2.76	2.68	− 2.9
7	128	88.5	18.00	15.93	12.4	6.83	5.12	4.94	− 3.5
8	29	26.0	14.00	3.64	12.6	6.77	1.16	1.13	− 2.6
9	107	74.8	18.50	13.83	12.9	6.58	4.28	4.28	0.0
10	37	29.1	17.25	5.02	13.6	6.26	1.48	1.55	+ 4.7
11	15	10.5	14.00	1.47	9.8	8.74	.60	.46	−23.3
12	135	100.0	14.25	14.25	10.5	8.05	5.40	4.42	−10.0
14	91	68.8	19.25	13.23	14.6	5.85	3.64	4.10	+12.6
16	51	41.7	17.00	7.09	13.9	6.11	2.04	2.20	+ 7.8
17	25	21.5	18.50	3.98	15.9	5.34	1.00	1.23	+23.0
18	29	21.5	15.50	3.33	11.5	7.40	1.16	1.03	−11.2
19	56	39.5	15.50	6.12	10.9	7.78	2.24	1.89	−15.1
20	96	60.3	18.25	11.00	11.5	7.42	3.84	3.41	−11.2
21	90	61.2	22.50	13.78	15.3	5.55	3.60	4.26	+18.4
22	29	23.0	16.50	3.80	13.1	6.49	1.16	1.18	+ 1.7
23	40	28.1	14.00	3.94	9.8	8.63	1.60	1.22	−23.8
24	27	20.0	17.00	3.40	12.6	6.75	1.08	1.05	− 2.8
25	68	48.3	20.00	9.66	14.2	5.98	2.72	2.99	+10.0
27	48	36.0	13.75	4.95	10.3	8.24	1.92	1.53	−20.3
28	9	6.0	12.75	.77	8.5	9.94	.36	.24	−33.3
33	100	68.0	23.25	15.81	15.8	5.38	4.00	4.90	+22.5
Total	1638			211.52			$65.52	$65.52	

* The numbers of patrons in this table represent the same persons as the corresponding numbers in the table on page 241.

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Comparison of the Space and Babcock Test Systems for One Week.*

Creamery No. 4, Feb. 12 to 19, 1894.

Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per cent. of Fat in the Cream.	Pounds of Fat in the Cream.	Pounds of Fat in 100 Spaces of Cream.	Number of Spaces to make a Pound of average Butter.	Value of the Cream by the Space System @ 4 cts. per Space.	Value of the Cream by the Babcock Test System @ 31$\frac{1}{16}$ cts. per Pound of Fat.	Payment by the Babcock Test System would give more (+) or less (—) than by the Space System in per cent.
1	82	62.75	17.00	10.67	13.0	6.53	$3.28	$3.33	+ 1.5
2	188	141.00	15.50	21.86	11.6	7.31	7.52	6.83	— 9.2
3	396	299.75	16 00	47.96	12.1	7.02	15.84	14.98	— 5.4
4	400	330.75	16.00	52.92	13.2	6.42	16.00	16.53	+ 3.3
5	282	240.25	16.50	39.64	14.1	6.04	11.28	12.38	+ 9.7
6	282	233.75	16.50	38.57	13.7	6.21	11.28	12.05	+ 6.8
7	423	294.00	16.50	48.51	11.4	7.41	16.92	15.16	—10.4
8	98	82.50	14.00	11.55	11.8	7.21	3.92	3.61	— 7.9
9	414	277.25	18.00	49.90	12.1	7.05	16.56	15.59	— 5.9
10	125	93.25	17.50	16.32	13.0	6.51	5.00	5.10	+ 2.0
11	47	31.25	14.00	4.38	9.3	9.12	1.88	1.37	—27.1
12	444	334.50	17.00	56.86	12 8	6.63	17.76	17.76	00.0
13	70	56.00	17.00	9.52	13.6	6.25	2.80	2.97	+ 6.1
14	341	247.75	20.25	50.17	14.7	5.77	13.64	15.67	+14 9
15	78	60.75	11.00	6.68	8.5	9.92	3.14	2.09	—33.4
16	144	115 25	17.25	19.88	13.8	6.16	5.76	6.21	+ 7.8
17	95	78.00	15.25	11.89	12.5	6.79	3.80	3.71	— 1.9
18	100	82.50	15.50	12.79	12.8	6.65	4.00	3.99	— 0.2
19	194	138.25	17.00	23.50	12.1	7.01	7.76	7.34	— 5.4
20	302	201.25	17.00	34.21	11.3	7.50	12.08	10.69	—11.5
21	400	271.00	22.00	59.62	14.9	5.70	16.00	18.63	+16.5
22	120	87.00	17.00	14.79	12.3	6.90	4.80	4.62	— 3.7
23	99	68.50	15.25	10.45	10.5	8.05	3.96	3.26	—17.7
24	86	66.00	17.75	11.71	13.6	6.24	3.44	3 66	+ 6.4
25	333	230.50	19.25	44.37	13.3	6.38	13.32	13.86	+ 4.1
26	113	81.75	19.50	15.94	14 1	6.03	4.52	4.98	+10.2
27	134	103.25	15.50	16.00	11.9	7.12	5.36	5.00	— 6.7
28	56	38.75	14.25	5.52	9.9	8.62	2.24	1.72	—23.2
33	100	66.00	24.50	16.17	16.2	5.25	4.00	5.05	+26.2
35	51	38.50	14.50	5.58	10.9	7.77	2.00	1.74	—14.7
	5997			767.93			$239.88	$239.88	

* See foot note, page 240.

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Comparison of the Space and Babcock Test Systems for One Gathering.

Creamery No. 5, April 23, 1891.

Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per cent. of Fat in the Cream.	Pounds of Fat in the Cream.	Pounds of Fat in 100 Spaces of Cream.	Number of Spaces to make a pound of average Butter.	Value of the Cream by the Space System @ 4 cents per Space.	Value of the Cream by the Babcock Test System @ 27.72 cents per pound of Fat.	Payment by the Babcock Test System would give more (+) or less (—) than by the Space System.
1	38	27.25	20.6	5.61	14.8	5.76	$1.52	$1.56	+ 2.6
2	28	22.00	20.3	4.47	15.9	5.32	1.12	1.25	+11.6
3	27½	19.50	20.7	4.04	14.7	5.78	1.10	1.13	+ 2.7
4	14	10.25	22.2	2.27	16.2	5.24	.56	.63	+12.5
5	24½	15.00	23.4	3.51	14.3	5.93	.98	.98	0.0
6	55	34.00	21.5	7.31	13.3	6.39	2.20	2.04	— 7.3
7	31½	21.75	19.8	4.31	13.7	6.21	1.26	1.20	— 4.8
8	20	11.75	20.4	2.40	12.0	7.08	.80	.67	—16.3
9	52	36.50	21.0	7.67	14.8	5.76	2.08	2.14	+ 2.9
10	11	7.50	23.7	1.78	16.2	5.25	.44	.50	+13.6
11	59	42.25	19.2	8.11	13.7	6.18	2.36	2.27	— 3.8
12	16½	11.50	20.7	2.38	14.4	5.89	.66	.66	0.0
13	29	20.75	18.9	3.92	13.5	6.29	1.16	1.09	— 6.0
14	16	11.25	20.1	2.26	14.1	6.02	.64	.63	— 1.6
15	50	34.75	19.8	6.88	13.8	6.18	2.00	1.93	— 3.5
16	26	18.75	21.0	3.94	15.2	5.61	1.04	1.10	+ 5.8
17	37	24.50	19.1	4.68	12 6	6.72	1.48	1,31	—11.5
18	26	18.25	21.3	3.89	14.9	5.68	1.04	1.09	+ 4.8
19	29	20.00	20.7	4.14	14.3	5.95	1.16	1.15	— .9
20	32	21.75	23.3	5.07	15.9	5.36	1.28	1.41	+10.1
21	68	48.50	20.7	10.04	14.8	5.75	2.72	2.81	+ 3.3
22	42	29.75	20.4	6.07	14.4	5.88	1.68	1.70	+ 1.2
23	22½	16.00	21.0	3.36	14.9	5.69	.90	.94	+ 4.4
24	15½	10.25	21.5	2.20	14.2	5.99	.62	.61	— 1.6
	770			110.31			$30.80	$30.80	

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Comparison of the Space and Babcock Test Systems for One Gathering.

Creamery No. 5, April 17, 1894.

Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per cent. of Fat in the Cream.	Pounds of Fat in the Cream.	Pounds of Fat in 100 Spaces of Cream.	Number of Spaces to make a pound of average Butter.	Value of the Cream by the Space System @ 4 cents per Space.	Value of the Cream by the Babcock Test System @ 28.16 cents per pound of Fat.	Payment by the Babcock Test System would give more (+) or less (—) than by the Space System.
1	22	15.50	19.50	3.02	13.6	6.19	$ .88	$ .87	— 1.1
2	38	25.75	18.75	4.83	12.7	6.69	1.52	1.38	— 9.2
3	23	16.25	19.50	3.17	13.7	6.17	.92	.91	— 1.1
4	20	14.25	20.00	2.85	14.1	5.97	.80	.82	+ 2.5
5	19	14.50	18.00	2.61	13.7	6.18	.76	.75	— 1.3
6	42	30.75	19.50	6.00	14.3	5.95	1.68	1.72	+ 2.4
7	18	14.00	18.50	2.59	14.3	5.90	.72	.74	+ 2.8
8	22	17.75	18.75	3.33	15.1	5.61	.88	.96	+ 9.1
9	49	35.00	19.75	6.91	14.0	6.03	1.96	1.98	+ 1.0
10	47	32.00	20.25	6.48	13.8	6.17	1.88	1.86	— 1.1
11	60	46.75	16.50	7.71	12.9	6.61	2.40	2.21	— 7.9
12	15	11.75	18.75	2.20	14.7	5.80	.60	.63	+ 5.0
13	146	101.50	20.50	20.81	14.1	5.96	5.84	5.96	+ 2.1
14	26	18.00	20.25	3.65	14.0	6.06	1.04	1.05	+ .9
15	24	16.50	19.75	3.26	13.6	6.25	.96	.93	— 3.1
16	33	22.25	21.75	4.84	14.7	5.80	1.32	1.39	— 5.3
17	32	22.00	17.50	3.85	12.0	7.07	1.28	1.10	—14.1
18	19	13.50	19.25	2.60	13.7	6.21	.76	.74	— 2.6
19	20	15.00	20.00	3.00	15.0	5.67	.80	.86	+ 7.5
20	30	21.25	21.25	4.52	15.1	5.64	1.20	1.29	+ 7.5
21	33	24.00	20.25	4.86	14.8	5.77	1.32	1.39	+ 5.3
22	39	28.50	19.75	5.63	14.4	5.88	1.56	1.61	+ 3.2
23	25	17.75	18.25	3.24	12.9	6.56	1.00	.93	— 7.0
24	57	42.75	19.50	8.34	14.6	5.81	2.28	2.39	+ 4.8
25	72	52.25	17.00	8.88	12.3	6.89	2.88	2.55	—11.5
26	28	21.25	16.00	3.40	14.8	5.75	.92	.97	+ 5.4
27	35	25.50	20.50	5.23	14.9	5.69	1.40	1.50	+ 7.1
28	23	17.00	17.00	2.89	12.6	6.76	.92	.83	— 9.8
29	17	12.50	16.50	2.06	12.1	7.01	.68	.59	—13.2
30	85	65.00	19.50	12.68	14.9	5.70	3.40	3.63	+ 6.8
31	27	19.25	20.00	3.85	14.3	5.96	1.08	1.10	+ 1.9
	1141			159.30			$45.64	$45.64	

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Comparison of the Space and Babcock Test Systems for One Gathering.

Creamery No. 6, April 18, 1894.

Number of Patron.	Spaces of Cream.	Pounds of Cream.	Per cent. of Fat in the Cream.	Pounds of Fat in the Cream.	Pounds of Fat in 100 Spaces of Cream.	Number of Spaces to make a pound of average Butter.	Value of the Cream by the Space System @ 4 cents per Space.	Value of the Cream by the Babcock Test System @ 31 1/16 cents per pound of Fat.	Payment by the Babcock Test System would give more (+) or less (—) than by the Space System.
1	26	17.5	15.75	2.76	10.6	8.01	$1.04	$ .87	—16.3
2	30	21.0	19.00	3.99	13.3	6.39	1.20	1.25	+ 4.2
3	40	27.5	17.00	4.68	11.7	7.26	1.60	1.47	— 8.1
4	43	27.0	19.00	5.13	11.9	7.14	1.72	1.61	— 6.4
5	24	18.0	19.25	3.47	14.5	5.88	.96	1.09	+13.5
6	34	23.0	18.50	4.26	12.5	6.80	1.36	1.34	— 1.5
7	31	21.5	15.75	3.39	10.9	7.79	1.24	1.07	—13.7
8	15	12.5	17.00	2.13	14.2	6.00	.60	.67	+11.6
9	19	17.0	16.00	2.72	14.3	5.94	.76	.85	+11.8
10	33	26.0	16.25	4.21	12.8	6.67	1.32	1.32	0.0
11	32	25.0	19.00	4.75	14.8	5.72	1.28	1.49	+16.4
12	58	36.0	20.25	7.29	12.6	6.76	2.32	2.29	— 1.3
13	67	42.0	21.00	8.82	13.2	6.46	2.68	2.77	+ 3.4
14	55	38.5	19.50	7.51	13.7	6.22	2.20	2.36	+ 7.3
15	20	15.0	16.50	7.48	12.4	6.86	.80	.78	— 2.5
16	42	30.0	19.50	5.85	13.9	6.10	1.68	1.84	+ 9.5
17	30	21.5	18.25	3.92	13.1	6.51	1.20	1.23	+ 2.5
18	22	14.0	19.00	2.66	12.1	7.03	.88	.84	— 4.5
19	23	17.0	17.00	2.89	12.6	6.76	.92	.91	— 1.1
20	57	40.5	17.25	6.99	12.3	6.93	2.28	2.20	— 3.5
21	17	12.0	16.00	1.92	11.3	7.52	.68	.60	—11.7
22	24	17.0	13.50	2.30	9.6	8.87	.96	.72	—25.0
24	40	29.0	18.50	5.37	13.5	6.33	1.60	1.70	+ 6.2
25	62	42.0	17.00	7.14	11.5	7.38	2.48	2.25	— 9.3
26	44	38.0	16.75	6.37	14.5	5.87	1.76	2.00	+13.6
Total	888			113.00			$35.52	$35.52	

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OBSERVATIONS ON THE GROWTH OF MAIZE CONTINUOUSLY ON THE SAME LAND.

By E. H. Jenkins.

In the years 1888 and 1889 a parcel of land containing 1¼ acres which had been a meadow for some years previous, was dressed with commercial fertilizers and planted to corn. Fertilizers and crops were weighed and analyzed each year and the enrichment or exhaustion of the soil by the dressing and cropping were determined as accurately as possible.

In the spring of 1890 this land was divided into four strips, each containing three-tenths of an acre, and was dressed as shown in the following diagram.

South.		North.
	Plot A.—Cow Manure at the rate of 10 cords per acre.	
	Plot B.—Hog Manure at the rate of 13½ cords per acre.	
	Plot C.—Fertilizer Chemicals at the rate of 1700 pounds per acre.	
	Plot D.—No manure or fertilizer of any kind.	

Corn was planted in drills four feet apart and the stalks stood singly at distances of ten inches in the drill. The crop from each plot was separately weighed and analyzed.

The several plots have received the same dressing as in 1890 annually since that time, have been planted with the same variety of seed and have been under the same conditions of planting, cultivation and harvesting.

Full particulars regarding the details of the experiment and the results obtained from year to year will be found in the Reports of this Station for 1890, pages 183 to 194; 1891, pages 139 to 149; 1892, pages 122 to 129; 1893, pages 286 to 300.

The experiment was repeated in 1894 precisely as in the four years previous.

The time and method of plowing, planting, cultivating, and harvesting was essentially the same as in previous years.

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Considering simply the gross amounts of nitrogen, phosphoric acid and potash which the dressing added to the soil of the several plots and those which the crops removed, it appears from Table VII, to be noticed later, that after the crop of 1894 was harvested there had been added to Plot A *per acre, in excess of what had been taken off in crops* over 930 pounds of nitrogen, 680 of phosphoric acid and 710 of potash, all from cow manure.

The corresponding enrichment of Plot B consisted *per acre*, of over 1570 pounds of nitrogen, 2890 of phosphoric acid and 100 of potash, all from hog manure. The very large excess of phosphoric acid in the hog manure is due to the fact that the hogs were fed chiefly on hotel garbage, which contained a large quantity of bones of fowls.

The enrichment of plot C, *per acre*, amounted to over 418 pounds of nitrogen, 831 of phosphoric acid and 158 of potash all from fertilizer-chemicals.

Plot D received fertilizer-chemicals in 1888 and 1889, but in the following four years no dressing of any sort; so that after the harvest of 1894 it had acquired, *per acre*, 65 pounds more of phosphoric acid (from the applications of 1888 and 1889), than the crops had removed, but had lost 287 pounds of nitrogen and 54 pounds of potash.

Plot B also received more "organic matter" from the dressing than plot A, while plot C acquired only an insignificant amount in the dressing of fertilizer-chemicals, and plot D none at all.

Plot A receives annually about 3,207 pounds, plot B about 5,440 pounds and plot C not more than 200 pounds of organic matter.

Gross Yield of the Plots in 1894.

Table I presents the gross weight of the kernels, cobs and stover harvested on each plot. Inasmuch as the kernels were air-dried on the cob, the weight of the latter in the field-cured condition could not be taken. Hence the weight of the kernels given in the table is slightly higher and that of the cobs slightly lower than it should be. But the error is small.

Table I.—Gross Yield of the Plots in Pounds per Acre. 1894.

	Plot A. Cow manure.	Plot B. Hog manure.	Plot C. Chemicals.	Plot D. No fertilizer.
Kernels.....	2808.4	2904.0	2886.1	1871.0
Cobs	361.7	396.0	402.5	259.0
Stover.....	3609.9	3930.0	3026.4	1920.0
Total.....	6780.0	7230.0	6315.0	4050.0

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Since these crops contain a large and variable quantity of water a strict comparison of the yields can only be made on the dry matter which the crops contain.

This appears in Table II.

TABLE II.—DRY MATTER OF THE CROPS, POUNDS PER ACRE. 1894.

	In Kernels.	In Cobs.	In Stover.	Total.
Plot A, cow manure	1770.4	323.0	1927.3	4020.7
Plot B, hog manure	1686.4	353.6	1805.4	3845.4
Plot C, fertilizer-chemicals	1761.1	859.4	1777.1	3897.6
Plot D, no fertilizer	1142.1	231.3	1317.9	2691.3

During the last five years there has been no striking difference in the crops of these four plots as far as the proportion of kernels, cobs and stover is concerned unless perhaps the crop on D which received neither fertilizers nor manure for five years, had a rather larger proportion of stover than the others. The figures are as follows:

TABLE IIA. PERCENTAGE OF WATER-FREE KERNELS, COBS AND STOVER, IN THE CROPS. AVERAGE OF FIVE YEARS.

	Plot A.	Plot B.	Plot C.	Plot D.
Kernels	45.9	46.4	45.3	43.3
Cobs	7.5	8.4	8.8	7.0
Stover	46.6	45.2	45.9	49.7
	100.00	100.00	100.0	100.0

Excess of nitrogen has not made the crop "run to leaves" nor has deficiency of plant food strikingly affected the relative proportion of ears and stalks.

The relative yields of dry matter from these plots for the last five years are given in Table III, the yield of plot A being marked in each case as 100.

TABLE III.—RELATIVE YIELD OF DRY MATTER FROM PLOTS A, B, C, D FOR FIVE YEARS.

	Plot A.	B.	C.	D.
1890	100	104.7	89.5	73.5
1891	100	92.9	82.0	65.9
1892	100	114.6	98.3	48.9
1893	100	95.1	73.2	43.1
1894	100	95.6	96.9	66.9
Average	100	100.6	88.0	59.7

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It appears that during the five years the two plots A and B which were dressed with heavy applications of manure have yielded on the average the same amount of water-free crop.

Plot C, dressed with fertilizer chemicals, supplying considerably more nitrogen, phosphoric acid and potash yearly than the crop removed, yielded on the average a little less than nine tenths as much, and plot D without fertilizers six tenths as much.

The relative yield on plot D fell steadily till 1894 when it rose very considerably.

This would indicate that this plot suffered less from the prolonged drought of the last summer than those which had been dressed with manure for a term of years and which contained much more humus.

During the last five years there has been a pretty regular falling off from year to year in the yield of all four plots as is shown in Table III[a], in which the yield of dry matter for each plot in 1890 is marked as 100.

TABLE III[a].—RELATIVE YIELD OF DRY MATTER IN THE FIVE YEARS FROM 1890 TO 1894.

	Plot A.	Plot B.	Plot C.	Plot D.
1890	100	100	100	100
1891	96	81	83	81
1892	79	87	88	53
1893	58	53	48	34
1894	44	41	48	41

The falling off in yield of Plot D is no doubt in part due to lack of plant food. In the other cases this cannot be the cause. Possibly the character of the seasons or deterioration of the seed corn may explain the lessened crops on the other plots.

YIELD OF EACH FOOD INGREDIENT.

In Table IV are given the quantities, in pounds per acre, of each food ingredient harvested from the four plots in 1894.

The cobs were not analyzed, but as their amount is relatively very small, the average composition of cobs as determined in other analyses, is used for the calculation.

The yield of each food ingredient from the four plots shows, in general, differences like those already noted in respect to the yield of total dry matter.

Table V shows the composition of the crops on the four plots, A, B, C, and D, for the year 1894.

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TABLE IV.—Yield of Food Ingredients in Pounds per Acre. 1894.

	Plot A.				Plot B.				Plot C.				Plot D.			
	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.
Water	1038.0	38.7	1682.6	2759.3	1217.6	42.4	2124 6	3384.6	1125.0	43.1	1249.3	2417.4	728.9	27.7	602.1	1358.7
Ash	23.9	5.1	143.3	172.3	24.1	5.5	131.7	161.3	20.2	5.6	140.4	166.2	13.1	3.6	80.6	97.3
Albuminoids	212.6	8.7	140.8	362.1	204.5	9.5	140.3	354.3	196.0	9.7	133.5	339.2	109.3	6.2	75.7	191.2
Fiber	35.6	108.8	612.6	757.0	32.8	119.2	543.5	695.5	34.6	121.1	555.6	711.3	23.4	78.0	437.6	539.0
Nitrogen-free extract	1395.5	198.6	998.8	2592.9	1331.8	217.4	956.5	2505.7	1414.5	221.0	919.1	2554.6	936.8	142.2	702.7	1781.7
Fat	102.8	1.8	31.8	136.4	93.2	2.0	33.4	128.6	95.8	2.0	28.5	126.3	59.5	1.3	21.3	82.1
	2808.4	361.7	3609.9	6780.0	2904.0	396.0	3930.0	7230.0	2886.1	402.5	3026.4	6315.0	1871.0	259.0	1920.0	4050.0

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TABLE V.—ANALYSES OF FIELD-CURED MAIZE, KERNELS AND STOVER, FROM PLOTS A, B, C, D. 1894.

	Analyses of Field-cured Maize.						Analyses, Calculated Water-free.				
	Water.	Ash.	Albuminoids.	Fiber.	Nitrogen-Free Extract	Fat.	Ash.	Albuminoids.	Fiber.	Nitrogen-Free Extract.	Fat.
KERNELS.											
Plot A	36.96	.85	7.57	1.27	49.69	3.66	1.36	12.01	2.02	78.81	5.80
Plot B	41.93	.83	7.04	1.13	45.86	3.21	1.44	12.12	1.95	78.97	5.52
Plot C	38.98	.70	6.79	1.20	49.01	3.32	1.15	11.12	1.97	80.32	5.44
Plot D	38.96	.70	5.84	1.25	50.07	3 18	1.15	9.57	2.04	82.03	5.21
STOVER.											
Plot A	46.61	3.97	3.90	16.97	27.67	.88	7.44	7.31	31.78	51.82	1.65
Plot B	54.06	3.35	3.57	13.83	24.34	.85	7.29	7,77	30.10	52.98	1.86
Plot C	41.28	4.64	4.41	18.36	30.37	.94	7.91	7-51	31.26	51.71	1.61
Plot D	31.36	4.20	3.94	22.79	36.60	1.11	6.13	5.74	33.20	53.32	1.61

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Table VI exhibits the striking differences in the percentage composition of the crop on the four plots calculated from the average of the five years.

The crops on A and B, which have been very heavily dressed each year, the one with cow manure the other with hog manure, have a like composition.

The crop on C, which receives each year a liberal dressing of fertilizer chemicals, 1500 pounds to the acre, contains in the kernels considerably less ash or mineral matter and albuminoids than the crops on A and B, and correspondingly more nitrogen-free extract (starch).

The kernels in the crop on D, to which no fertilizer or manure has been applied since 1889, have 1½ per cent. less albuminoids than that of plots A and B, somewhat less ash and fat, but more fiber and nitrogen-free extract.

TABLE VI.—AVERAGE COMPOSITION OF THE DRY MATTER OF KERNELS AND STOVER OF CROPS OF 1890, 1891, 1892, 1893 AND 1894.

	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
KERNELS.					
Plot A	1.39	11.26	1.69	80.32	5.34
" B	1.41	11.02	1.69	80.66	5.22
" C	1.26	10.60	1.73	81.30	5.11
" D	1.24	9.53	1.85	82.46	4.92
STOVER.					
Plot A	6.80	6.40	32.80	52.51	1.49
" B	6.46	6.63	32.59	52.80	1.52
" C	6.50	6.65	32.70	52.72	1.43
" D	5.94	6.01	32.77	53.83	1.45

To complete the data regarding this experiment two other tables are given.

Table VII gives the quantities of nitrogen, phosphoric acid and potash which were added in the manure or fertilizers and remained in the crops of 1894.

It also gives the amounts of those fertilizing materials which have been added to the soil capital (+) or withdrawn (—) in the seven years during which accurate account has been kept.

Table VIII gives the record of the crops on the four plots for the whole period covered by the experiment and also the percentage composition of the several crops.

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TABLE VII.—ENRICHMENT OR IMPOVERISHMENT OF SOIL BY SEVEN YEARS' MANURING AND CROPPING.
POUNDS PER ACRE.

	Cow Manure. Plot A.			Hog Manure. Plot B.			Fertilizer Chemicals. Plot C.			No Fertilizer. Plot D.		
	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.
After six years' cropping	+706.2	+561.8	+570.5	+1207.8	+2330.0	+ 68.5	+300.9	+683.3	+129.4	−256.9	+73.6	−40.0
Applied in 1894.....	286.3	136.4	204.5	419.9	586.5	72.4	172.0	162.0	69.0	00.0	00.0	00.0
Taken off in Crop of 1894	57.9	17.5	63.3	56.7	18.5	39.6	54.3	13.9	39.7	30.6	8.2	14.3
Excess (+) or Deficiency (−) after seven years' cropping	+934.6	+680.7	+711.7	+1571.0	+2898.0	+101.3	+418.6	+831.4	+158.7	−287.5	+65.4	−54.3

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TABLE VIII.—YIELD OF DRY MATTER AND "SHELLED CORN" PER ACRE FOR SEVEN YEARS AND COMPOSITION OF DRY MATTER.

	Year.	Distance of Planting.	Pounds of Dry Matter per Acre.	Bushels of Shelled Corn.	Percentage Composition of Dry Matter				
					Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
Fertilized alike with chemicals..	1888	Stalks 12 inches apart.	7350	75	3.3	7.8	19.4	66.1	3.4
	1888	" 6 " "	7980						
	1889	" 12 " "	6144	60	3.5	6.1	21.7	69.7	3.0
	1889	" 6 " "	6353						
Cow Manure	1890A	" 10 " "	9014	91	4.0	7.9	19.8	65.7	2.6
Hog Manure	1890B	" 10 " "	9436	97	4.2	8.0	19.6	65.5	2.7
Fertilizer Chemicals	1890C	" 10 " "	8070	87	3.9	8.0	21.2	64.4	2.5
No Manure or Fertilizer	1890D	" 10 " "	6626	51	3.8	6.2	20.7	66.7	2.6
Cow Manure	1891A	" 12 " "	8176	103	3.2	7.5	15.5	70.2	3.6
Hog Manure	1891B	" 12 " "	7599	88	3.3	7.6	16.2	69.3	3.6
Fertilizer Chemicals	1891C	" 12 " "	6708	70	3.2	6.4	18.5	68.8	3.1
No Manure or Fertilizer	1891D	" 12 " "	5391	60	3.1	6.0	17.4	70.2	3.3
Cow Manure	1892A	" 12 " "	7181	72	4.0	8.2	19.6	65.1	3.1
Hog Manure	1892B	" 12 " "	8233	84	4.0	8.8	19.3	64.8	3.1
Fertilizer Chemicals	1892C	" 12 " "	7062	86	3.2	8.3	17.5	67.8	3.2
No Manure or Fertilizer	1892D	" 12 " "	3509	38	3.3	7.7	18.8	67.2	3.0
Cow Manure	1893A	" 12 " "	5277	53	4.3	8.8	20.8	63.3	2.8
Hog Manure	1893B	" 12 " "	5020	52	3.8	8.4	21.1	63.9	2.8
Fertilizer Chemicals	1893C	" 12 " "	3858	37	3.8	9.0	21.6	63.0	2.6
No Manure or Fertilizer	1893D	" 12 " "	2277	18	4.6	8.2	22.5	62.4	2.3
Cow Manure	1894A	" 12 " "	4021	42	4.3	9.0	18.8	64.5	3.4
Hog Manure	1894B	" 12 " "	3845	40	4.2	9.2	18.1	65.2	3.3
Fertilizer Chemicals	1894C	" 12 " "	3898	42	4.3	8.7	18.2	65.5	3.3
No Manure or Fertilizer	1894D	" 12 " "	2691	27	3.6	7.2	20.0	66.2	3.0

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LOT B.

Fertilizers: 1760 lbs. linseed meal, 1660 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 138 lbs. phosphoric acid and 340 lbs. potash. Cost, $57.79 per ton.

Yield:	585	lbs.	long	wrappers	per acre.
	190	"	short	"	" "
Total	775	"			

Quality:—*Burn*, very free, holds fire well, does not coal. *Ash*, clear white, does not flake. *Vein*, small, fine, some white. *Texture*, clear, unsweated, good grain. *Size*, very desirable. *Ripeness*, ripe. *Colors*, fairly good. *Yield*, desirable. *Taste*, fair. *Stem*, medium to small. *Relative rank*, 1st.

LOT C.

Fertilizers: 2500 lbs. cotton seed meal, 1540 lbs. cotton hull ashes per acre, containing 175 lbs. nitrogen, 172 lbs. phosphoric acid and 342 lbs. potash. Cost, $73.88 per acre.

Yield:	475	lbs.	long	wrappers	per acre.
	165	"	short	"	" "
Total	640	"			

Quality:—*Burn*, free, holds fire well, does not coal. *Ash*, clear white, does not flake. *Vein*, small, fine. *Texture*, clear, unsweated, good grain. *Size*, very desirable. *Ripeness*, ripe. *Colors*, fairly good. *Yield*, desirable. *Taste*, fair. *Stem*, medium. *Relative rank*, 5th.

LOT D.

Fertilizers: 3000 lbs. cotton seed meal, 1500 lbs. cotton hull ashes per acre, containing 210 lbs. nitrogen, 184 lbs. phosphoric acid and 342 lbs. potash. Cost, $81.00 per acre.

Yield:	535	lbs.	long	wrappers	per acre.
	185	"	short	"	" "
Total	720	"			

Quality:—*Burn*, free, holds fire well, coals slightly. *Ash*, clear gray and does not flake. *Vein*, medium, curly. *Texture*, mottled, unsweated, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium. *Yield*, desirable. *Taste*, fair. *Stem*, medium. *Relative rank*, 8th.

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LOT E.

Fertilizers: 2260 lbs. castor pomace, 1660 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 139 lbs. phosphoric acid, 340 lbs. potash. Cost, $64.60 per acre.

Yield: 605 lbs. long wrappers per acre.
185 " short " " "
Total 790 "

Quality:—*Burn*, free, holds fire well, inclined to coal. *Ash*, mixed gray, but does not flake. *Vein*, prominent, curly, white. *Texture*, mottled, unsweated, close grain. *Size*, desirable. *Ripeness*, not quite ripe. *Colors*, unsweated, bad. *Yield*, undesirable. *Taste*, bitter. *Stem*, medium, woody. *Relative rank*, 29th.

LOT F.

Fertilizers: 1760 lbs. linseed meal, 660 lbs. cotton hull ashes, 260 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 150 lbs. phosphoric acid, 150 lbs. potash. Cost, $41.79 per acre.

Yield: 725 lbs. long wrappers per acre.
185 " short " " "
Total 910 "

Quality:—*Burn*, free, holds fire well, coals slightly. *Ash*, clear gray, does not flake. *Vein*, small, fine. *Texture*, mottled, unsweated, dry, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium. *Yield*, desirable. *Taste*, fair. *Stem*, small. *Relative rank*, 3d.

LOT G.

Fertilizers: 3760 lbs. castor pomace, 1560 lbs. cotton hull ashes per acre, containing 175 lbs. nitrogen, 154 lbs. phosphoric acid and 342 lbs. potash. Cost $81.32 per acre.

Yield: 425 lbs. long wrappers per acre.
220 " short " " "
Total 645 "

Quality:—*Burn*, fairly free, holds fire fairly well, does not coal. *Ash*, clear gray, does not flake. *Vein*, medium. *Texture*, mottled, gummy, unsweated, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, undesirable. *Yield*, desirable. *Taste*, fair. *Stem*, medium. *Relative rank*, 22d.

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LOT H.

Fertilizers: 4520 lbs. castor pomace, 1520 cotton hull ashes per acre, containing 210 lbs. nitrogen, 164 lbs. phosphoric acid, 342 lbs. potash. Cost $89.94 per acre.

Yield: 690 lbs. long wrappers per acre.
210 " short " " "
Total 900 "

Quality:—*Burn*, Very free, holds fire well, does not coal. *Ash*, clear gray, does not flake. *Vein*, white. *Texture*, gummy, mottled, unsweated, good grain. *Size*, little large. *Ripeness*, ripe. *Colors*, medium. *Yield*, good. *Taste*, fair. *Stem*, large and woody. *Relative rank*, 9th.

LOT I.

Fertilizers: 2260 lbs. castor pomace, 1660 lbs. cotton hull ashes, 656 lbs. nitrate of soda (the latter in two applications after planting), per acre, containing 210 lbs. nitrogen, 139 lbs phosphoric acid, 340 lbs. potash. Cost, $81.96 per acre.

Yield: 670 lbs. long wrappers per acre.
185 " short " " "
Total 855 "

Quality:—*Burn*, fairly free, holds fire well, coals slightly. *Ash*, clear gray, does not flake. *Vein*, curly, white. *Texture*, unsweated, gummy, mottled, good grain. *Size*, desirable. *Ripeness*, not quite ripe. *Colors*, bad. *Yield*, poor. *Taste*, fair. *Stem*, medium to small. *Relative rank*, 21st.

LOT J.

Fertilizers: 2260 lbs. castor pomace, 1660 lbs. cotton hull ashes, 656 lbs. nitrate of soda per acre (the latter applied after planting), containing 210 lbs. nitrogen, 139 lbs. phosphoric acid, 340 lbs. potash. Cost $81.96 per acre.

Yield 805 lbs. long wrappers per acre.
260 " short " " "
Total 1065 "

Quality:—*Burn*, very free, holds fire well, does not coal. *Ash*, clear gray, does not flake. *Vein*, small, inclined to be white. *Texture*, fairly good but unsweated, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium, mottled. *Yield*, good. *Stem*, medium. *Relative rank*, 6th.

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LOT K.

Fertilizers: 1500 lbs. cotton seed meal, 1220 lbs. double manure salt, 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 342 lbs. potash. Cost, $47.12 per acre.

Yield: 750 lbs. long wrappers per acre.
190 " short " " "
Total 940 "

Quality :—*Burn*, holds fire fairly well, fairly free burn, coals slightly. *Ash*, clear gray, does not flake. *Vein*, curly, white. *Texture*, dry, unsweated, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium. *Yield*, good. *Stem*, medium. *Relative rank*, 15th.

LOT L.

Fertilizers: 1500 lbs. cotton seed meal, 1220 lbs. double manure salt, 360 lbs. Cooper's bone, 300 lbs. lime per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 342 lbs. potash. Cost, $47.94 per acre.

Yield: 515 lbs. long wrappers per acre.
185 " short " " "
Total 700 "

Quality :—*Burn*, holds fire fairly well, free burn, coals very slightly. *Ash*, medium flaky, gray. *Vein*, medium. *Texture*, unsweated, mottled and gummy, good grain. *Size*, medium. *Ripeness*, ripe. *Colors*, poor. *Yield*, fair. *Taste*, fair. *Stem*, medium. *Relative rank*, 25th.

LOT M.

Fertilizers: 1500 lbs. cotton seed meal, 620 lbs. high grade sulphate of potash, 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 340 lbs. potash. Cost $45.87 per acre.

Yield: 455 lbs. long wrappers per acre.
195 " short " " "
Total 650 "

Quality :—*Burn*, holds fire fairly well, free burn, coals somewhat. *Ash*, mixed gray and flakes somewhat. *Vein*, prominent and curly. *Texture*, gummy and mottled, unsweated, good grain. *Size*, very desirable. *Ripeness*, ripe. *Colors*, poor. *Yield*, good. *Taste*, fair. *Stem*, medium. *Relative rank*, 28th.

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LOT H.

Fertilizers: 4520 lbs. castor pomace, 1520 cotton hull ashes per acre, containing 210 lbs. nitrogen, 164 lbs. phosphoric acid, 342 lbs. potash. Cost $89.94 per acre.

Yield: 690 lbs. long wrappers per acre.
210 " short " " "
Total 900 "

Quality:—*Burn*, Very free, holds fire well, does not coal. *Ash*, clear gray, does not flake. *Vein*, white. *Texture*, gummy, mottled, unsweated, good grain. *Size*, little large. *Ripeness*, ripe. *Colors*, medium. *Yield*, good. *Taste*, fair. *Stem*, large and woody. *Relative rank*, 9th.

LOT I.

Fertilizers: 2260 lbs. castor pomace, 1660 lbs. cotton hull ashes, 656 lbs. nitrate of soda (the latter in two applications after planting), per acre, containing 210 lbs. nitrogen, 139 lbs phosphoric acid, 340 lbs. potash. Cost, $81.96 per acre.

Yield: 670 lbs. long wrappers per acre.
185 " short " " "
Total 855 "

Quality:—*Burn*, fairly free, holds fire well, coals slightly. *Ash*, clear gray, does not flake. *Vein*, curly, white. *Texture*, unsweated, gummy, mottled, good grain. *Size*, desirable. *Ripeness*, not quite ripe. *Colors*, bad. *Yield*, poor. *Taste*, fair. *Stem*, medium to small. *Relative rank*, 21st.

LOT J.

Fertilizers: 2260 lbs. castor pomace, 1660 lbs. cotton hull ashes, 656 lbs. nitrate of soda per acre (the latter applied after planting), containing 210 lbs. nitrogen, 139 lbs. phosphoric acid, 340 lbs. potash. Cost $81.96 per acre.

Yield 805 lbs. long wrappers per acre.
260 " short " " "
Total 1065 "

Quality:—*Burn*, very free, holds fire well, does not coal. *Ash*, clear gray, does not flake. *Vein*, small, inclined to be white. *Texture*, fairly good but unsweated, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium, mottled. *Yield*, good. *Stem*, medium. *Relative rank*, 6th.

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LOT K.

Fertilizers: 1500 lbs. cotton seed meal, 1220 lbs. double manure salt, 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 342 lbs. potash. Cost, $47.12 per acre.

Yield: 750 lbs. long wrappers per acre.
190 " short " " "
Total 940 "

Quality :—*Burn*, holds fire fairly well, fairly free burn, coals slightly. *Ash*, clear gray, does not flake. *Vein*, curly, white. *Texture*, dry, unsweated, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium. *Yield*, good. *Stem*, medium. *Relative rank*, 15th.

LOT L.

Fertilizers: 1500 lbs. cotton seed meal, 1220 lbs. double manure salt, 360 lbs. Cooper's bone, 300 lbs. lime per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 342 lbs. potash. Cost, $47.94 per acre.

Yield: 515 lbs. long wrappers per acre.
185 " short " " "
Total 700 "

Quality :—*Burn*, holds fire fairly well, free burn, coals very slightly. *Ash*, medium flaky, gray. *Vein*, medium. *Texture*, unsweated, mottled and gummy, good grain. *Size*, medium. *Ripeness*, ripe. *Colors*, poor. *Yield*, fair. *Taste*, fair. *Stem*, medium. *Relative rank*, 25th.

LOT M.

Fertilizers: 1500 lbs. cotton seed meal, 620 lbs. high grade sulphate of potash, 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 340 lbs. potash. Cost $45.87 per acre.

Yield: 455 lbs. long wrappers per acre.
195 " short " " "
Total 650 "

Quality :—*Burn*, holds fire fairly well, free burn, coals somewhat. *Ash*, mixed gray and flakes somewhat. *Vein*, prominent and curly. *Texture*, gummy and mottled, unsweated, good grain. *Size*, very desirable. *Ripeness*, ripe. *Colors*, poor. *Yield*, good. *Taste*, fair. *Stem*, medium. *Relative rank*, 28th.

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LOT N.

Fertilizers: 1500 lbs. cotton seed meal, 620 lbs. high grade sulphate of potash, 360 lbs. Cooper's bone, 300 lbs. lime per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 340 lbs. potash. Cost, $46.69 per acre.

Yield: 590 lbs. long wrappers per acre.
240 " short " " "
Total 830 "

Quality:—*Burn*, holds fire well, free burn. *Ash*, blue white, does not flake. *Vein*, prominent and curly. *Texture*, gummy, mottled, unsweated, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, fair. *Yield*, good. *Taste*, fair. *Stem*, medium. *Relative rank*, 19th.

LOT O.

Fertilizers: 1500 lbs. cotton seed meal, 580 lbs. carbonate of potash, 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 342 lbs. potash. Cost, 78.12* per acre.

Yield: 435 lbs. long wrappers per acre.
200 " short " " "
Total 635 "

Quality:—*Burn*, holds fire fairly well, free burn, but coals somewhat. *Ash*, gray, does not flake. *Vein*, woody, white, not prominent. *Texture*, gummy, mottled, unsweated, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, fair. *Yield*, good. *Taste*, fair. *Stem*, medium. *Relative rank*, 24th.

LOT. P.

Fertilizers: 1500 lbs. cotton seed meal, 1740 lbs. double carbonate of potash and magnesia, 360 lbs. Cooper's bone per acre, containing 110 lbs. nitrogen, 150 lbs. phosphoric acid, 342 lbs. potash. Cost, $62.75* per acre.

Yield: 480 lbs. long wrappers per acre.
235 " short " " "
Total 715 "

Quality:—*Burn*, free, holds fire very well. *Ash*, gray, does not flake. *Vein*, fine. *Texture*, fairly good, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium to good. *Yield*, good. *Taste*, fair. *Stem*, light. *Relative rank*, 14th.

* If bought in ton lots, not chemically pure, the cost would be considerably less.

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LOT Q.

Fertilizers: 2000 lbs. Baker's AA superphosphate, 4000 lbs. Baker's tobacco manure per acre, containing 233 lbs. nitrogen, 456 lbs. phosphoric acid, 533 lbs. potash.

Yield: 850 lbs. long wrappers per acre.
200 " short " " "
Total 1050 "

Quality:—*Burn*, fairly free, does not hold fire very well. *Ash*, firm, black and white. *Vein*, prominent and curly. *Texture*, harsh, undesirable. *Size*, medium to large. *Ripeness*, ripe. *Colors*, medium to good. *Yield*, undesirable. *Stem*, large. *Relative rank*, 20th.

LOT R.

Fertilizers: 2000 lbs. Stockbridge tobacco manure, 500 lbs. Stockbridge tobacco manure* per acre, containing 153 lbs. nitrogen, 245 lbs. phosphoric acid, 302 lbs. potash.

Yield: 455 lbs. long wrappers per acre.
165 " short " " "
Total 620 "

Quality:—*Burn*, free, does not coal, holds fire. *Ash*, mixed gray. *Vein*, prominent, curly. *Texture*, mottled, unsweated, good grain. *Size*, medium. *Ripeness*, ripe. *Colors*, poor. *Yield*, undesirable. *Taste*, fair. *Stem*, medium. *Relative rank*, 17th.

LOT S.

Fertilizers: 3000 lbs. Stockbridge tobacco manure, 500 lbs. Stockbridge tobacco manure* per acre, containing 214 lbs. nitrogen, 343 lbs. phosphoric acid, 403 lbs. potash.

Yield: 615 lbs. long wrappers per acre.
215 " short " " "
Total 830 "

Quality:—*Burn*, free, does not coal, holds fire fairly well. *Ash*, mixed gray, does not flake. *Vein*, not prominent, but some white. *Texture*, fairly good, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, fair. *Yield*, desirable. *Taste*, fair. *Stem*, medium. *Relative rank*, 7th.

* Applied as a starter.

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LOT T.

Fertilizers: 880 lbs. dry fish, 440 lbs. nitrate of soda, 720 lbs. Cooper's bone, 300 lbs. lime per acre, containing 153 lbs. nitrogen, 268 lbs. phosphoric acid, no potash. Cost, $42.05 per acre.

Yield: 735 lbs. long wrappers per acre.
180 " short " " "
Total 915 "

Quality:—*Burn*, free, does not coal, holds fire fairly well. *Ash*, light gray, does not flake. *Vein*, prominent, curly. *Texture*, gummy, harsh and undesirable, good grain. *Size*, not desirable. *Ripeness*, ripe. *Colors*, mottled and dry. *Yield*, undesirable. *Taste*, fair. *Stem*, medium. *Relative rank*, 18th.

LOT U.

Fertilizers: 600 lbs. Mapes' starter, 2200 lbs. Mapes' tobacco manure, wrapper brand per acre, containing 147 lbs. nitrogen, 206 lbs. phosphoric acid, 259 lbs. potash.

Yield: 975 lbs. long wrappers per acre.
250 " short " " "
Total 1225 "

Quality:—*Burn*, fairly free, coals slightly, holds fire fairly well. *Ash*, light gray, does not flake. *Vein*, prominent, curly. *Texture*, desirable, fine with good grain. *Size*, a little large. *Ripeness*, ripe. *Colors*, medium to good. *Yield*, desirable. *Stem*, medium. *Relative rank*, 4th.

LOT V.

Fertilizers: 800 lbs. Mapes' tobacco starter, 2000 lbs. Mapes' tobacco manure, wrapper brand per acre, containing 141 lbs. nitrogen, 220 lbs. phosphoric acid and 244 lbs. potash.

Yield: 690 lbs. long wrappers per acre.
180 " short " " "
Total 870 "

Quality:—*Burn*, fairly free, does not coal, holds fire fairly well. *Ash*, light gray, does not flake. *Vein*, not prominent, but some white. *Texture*, fairly well sweated, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, fairly good. *Yield*, good. *Taste*, fair. *Stem*, medium to heavy. *Relative rank*, 11th.

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LOT W.

Fertilizers: 1000 lbs. Mapes' starter, 1800 lbs. Mapes' tobacco manure, wrapper brand per acre, containing 135 lbs. nitrogen, 232 lbs. phosphoric acid, 229 lbs. potash.

Yield: 615 lbs. long wrappers per acre.
165 " short " " "

Total 780 "

Quality:—*Burn*, fairly free, coals slightly, holds fire well. *Ash*, light gray, does not flake. *Vein*, medium. *Texture*, good, good grain. *Size*, desirable. *Ripeness*, ripe. *Colors*, fairly good, fairly well sweated. *Yield*, desirable. *Taste*, fair. *Stem*, medium. *Relative rank*, 2d.

LOT X.

Fertilizers: 2000 lbs. Sanderson's formula per acre, containing 103 lbs. nitrogen, 281 lbs. phosphoric acid, 105 lbs. potash.

Yield: 525 lbs. long wrappers per acre.
200 " short " " "

Total 725 "

Quality:—*Burn*, not free, coals very slightly, does not hold fire. *Ash*, light gray, does not flake. *Vein*, medium. *Texture*, unsweated, gummy and mottled. *Size*, not desirable. *Ripeness*, ripe. *Colors*, very bad. *Yield*, not desirable. *Stem*, small. *Relative rank*, 27th.

LOT Y.

Fertilizers: 1500 lbs. cotton seed meal, 5620 lbs. unleached wood ashes, 160 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 153 lbs. phosphoric acid, 342 lbs. potash. Cost, $59.74 per acre.

Yield: 360 lbs. long wrappers per acre.
125 " short " " "

Total 485 "

Quality:—*Burn*, holds fire fairly well, fairly free burn, coals slightly. *Ash*, light gray, does not flake. *Vein*, small, white. *Texture*, gummy, unsweated. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium. *Yield*, desirable. *Taste*, fair. *Stem*, very small. *Relative rank*, 10th.

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LOT Z.

Fertilizers: 1300 lbs. dry fish, 1220 lbs. double manure salt, 200 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 147 lbs. phosphoric acid, 342 lbs. potash. Cost, $52.12 per acre.

Yield:	315	lbs.	long	wrappers	per acre.
	150	"	short	"	" "
Total	465	"			

Quality:—*Burn*, holds fire fairly, fairly free burn, does not coal. *Ash*, light gray, does not flake. *Vein*, small, fine. *Texture*, unsweated, gummy. *Size*, desirable. *Ripeness*, ripe. *Colors*, poor. *Yield*, desirable. *Taste*, fair. *Stem*, small. *Relative rank*, 12th.

LOT AA.

Fertilizers: 10–12 cords stable manure, and on half the plot 500 lbs. swift-sure superphosphate as a starter per acre, containing 126 lbs. nitrogen, 143 lbs. phosphoric acid, 172 lbs. potash.

Yield:	270	lbs.	long	wrappers	per acre.
	255	"	short	"	" "
Total	525	"			

Quality:—*Burn*, holds fire well, free burn, but coals. *Ash*, mixed gray, does not flake. *Vein*, small and fine. *Texture*, good, unsweated, rather close grain. *Size*, very desirable. *Ripeness*, ripe. *Colors*, mottled and bad. *Yield*, good. *Taste*, fair. *Stem*, very small. *Relative rank*, 13th.

LOT BB.

Fertilizers: 6000 lbs. tobacco stems, 2640 lbs. castor pomace. On one-half the plot 500 lbs. swift-sure superphosphate as a starter per acre, containing 252 lbs. nitrogen, 146 lbs. phosphoric acid, 538 lbs. potash. Cost, $84.80 per acre.

Yield:	300	lbs.	long	wrappers	per acre.
	180	"	short	"	" "
Total	480	"			

Quality:—*Burn*, holds fire well, free burn, coals very slightly. *Ash*, mixed gray, does not flake. *Vein*, small, fine. *Texture*, good, unsweated, rather close grain. *Size*, very desirable. *Ripeness*, ripe. *Colors*, mottled and bad. *Yield*, good. *Taste*, fair. *Stem*, very small. *Relative rank*, 16th.

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LOT CC.

Fertilizers: Pinney's Formula, containing 139 lbs. nitrogen, 210 lbs. phosphoric acid, 224 lbs. potash per acre.

Yield: 175 lbs. long wrappers per acre.
155 " short " " "
Total 330 "

Quality:—*Burn*, fairly free, does not hold fire well, coals slightly. *Ash*, mixed gray, does not flake. *Vein*, small, fine. *Texture*, good, but unsweated, rather close grain. *Size*, very desirable. *Ripeness*, ripe. *Colors*, mottled and bad. *Yield*, good. *Stem*, small. *Relative rank*, 26th.

The lots in order of their value as wrappers, taking all points into consideration, were arranged by Mr. Haas as follows:—

B, (best), W, F, U, C, J, S, D, H, Y, V, Z,
1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th,
AA, P, K, BB, R, T, N, Q, I, G, A, O,
13th, 14th, 15th, 16th, 17th, 18th, 19th, 20th, 21st, 22d, 23d, 24th,
L, CC, X, M, E.
25th, 26th, 27th, 28th, 29th.

DISCUSSION OF THE QUALITY OF THE FERMENTED TOBACCO, CROPS OF 1893.

It must be borne in mind in considering these statements of the judge that there was no really good tobacco in any of the lots. They were all badly damaged by drought, and between the lots scored as best and those scored as poorest there was no great difference in quality. All the plots, however, did not suffer equally from drought. Its effects were especially severe on those plots Y, Z, AA, BB, and CC which were planted for the first time in 1893. Those which had been tilled the previous year suffered less.

Comparing the 1893 crop with that of 1892, it appears that of the seven plots which bore the best tobacco in 1892 only two are among the seven best in 1893 (C and F). Of the seven plots which bore the poorest tobacco in 1892 only two are among the seven poorest in 1893 (M and X).

It is questionable whether any fair conclusions can be drawn as to the effects of different fertilizers on the quality of the

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tobacco when it seems probable that the drought rather than the fertilizers controlled the quality of the crop.

It is a striking fact that the fermented tobacco of 1893 crop from almost all the plots had a fair to very good burning quality, considerably better in fact than the 1892 crop from the experiment field, which was regarded by the judges, and especially by the manufacturers who bought and worked it into cigars as exceptionally good.

The judge's report on the burn of the two crops was as follows :

	1892 Crops.	1893 Crops.*
Burn "very free to free"	14	23
Burn "not free"	19	1
	* 24	24
Hold fire "very well to well"	10	13
Hold fire fairly well	8	9
"Do not hold fire"	6	2
	24	24
"Do not coal"	9	13
"Coal slightly"	11	11
"Coal"	4	0
	24	24

The defects of the experimental crop of 1893, common to the tobacco of nearly all the plots, and therefore attributed to conditions of weather are wholly in the "texture" and "colors." These defects cannot be defined at present more accurately than is done in the judge's report. Most of the tobacco is called "unsweated." But that it did ferment to some extent is certain. It lost as much weight in the case as the 1892 crop.

That the tobacco was of quite inferior quality was evident when it was sorted and before it was "sweated" or fermented. The popular saying "burn in tobacco is everything," does not hold in the present state of the trade. Desirable burn, texture and color are everything, and either two of the three are of no account without the other.

Comparative Fire-Holding Capacity.

In addition to the tests made by the expert a more extensive test was made at the Station laboratory by Messrs. Winton and

* Includes only those plots on which tobacco was grown in 1892.

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Ogden, following the method described in the Station Report for 1893, p. 124.

The lot which held fire the shortest time is marked 100 and the other lots are so marked as to express numerically their comparative capacity for holding fire: for example, lot Z held fire for a shorter time than any other (100); lot AA held fire about 2¼ times as long (227).

COMPARATIVE FIRE-HOLDING CAPACITY. FERMENTED CROP OF 1893.

	Long Wrappers.	Short Wrappers.	Calculated from mean of both.	Average number of seconds during which leaf holds fire. Unfermented.	Fermented.
A	246	319	252	11	22
B	233	308	246	14	21
C	224	282	229	10	20
D	243	298	245	9	22
E	252	231	217	8	21
F	393	354	380	11	32
G	198	143	197	10	15
H	209	212	198	11	19
I	313	383	301	10	27
J	228	536	354	11	24
K	160	223	174	8	14
L	217	147	213	7	15
M	210	182	203	7	17
N	229	155	170	8	18
O	252	260	230	8	21
P	281	382	303	12	25
Q	111	166	126	6	10
R	100	172	125	7	9
S	203	169	166	8	17
T	120	121	109	7	10
U	149	230	173	8	14
V	179	225	103	9	16
W	151	185	152	8	14
X	108	115	101	7	9
Y	186	309	226	8	18
Z	114	100	100	5	10
AA	235	269	227	9	20
BB	154	178	150	8	13
CC	118	180	136	7	11

The fire-holding capacity of all the lots was increased by fermentation though not by any means equally in all cases.

The *average* fire-holding capacity before fermentation was 9 seconds, after fermentation 18 seconds.

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The average of the 1892 crop was, before fermentation 9.6 seconds, after fermentation 24.4 seconds.

The better "burn" of the '93 crop as compared with that of '92 is due rather to its greater freedom from "coal" and its "free" burn when wrapped on cigars, than to its fire-holding capacity.

A more accurate method of determining fire-holding capacity is desirable. Tobaccos can only be fairly compared by this method when they are equally damp. But it is well-nigh impossible to get the crop of different seasons into the same condition of moisture in every case.

Nevertheless there is substantial agreement between the judgment of the expert on the fire-holding capacity of the different lots and the results of the laboratory tests on this point.

Thus, a study of the data regarding the two fermented crops of 1892 and 1893 shows that of the nine lots which the expert claimed did not "hold fire," eight had less than the average fire-holding capacity as determined in the laboratory. The ninth lot had just the average.

Of the twenty which the expert marked as holding fire only "fairly well," eighteen lots had less than average fire-holding capacity, as determined in the laboratory.

Of the twenty-seven lots which held fire well in the expert's opinion, only seven had less than average fire-holding capacity in laboratory tests.

Tendency to "coal" when wrapped on a cigar is not apparently associated with deficiency in fire-holding capacity. Thus, of twenty-nine lots which "coaled" more or less, fifteen had more than average fire-holding capacity.

Effect of Large Quantities of Cotton Seed Meal and Comparison of Cotton Seed Meal and Castor Pomace.

(Plots A, C, D, compared with E, G, H).

In 1893 castor pomace produced a larger yield of wrappers than equivalent quantities of cotton seed meal; on the average 778 lbs. per acre, as against 682 lbs. produced by cotton seed meal. The quality of that grown with cotton seed meal was somewhat better than the other.

The heaviest applications, 3000 lbs. of cotton seed meal and 4520 lbs. of castor pomace per acre, gave the best quality of leaf as well as the largest yield. This latter observation was also made on the crops of 1892.

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Linseed Meal as a Fertilizer.

(Plot B compared with A and E; also note plot F).

The best tobacco in 1893 was raised with linseed meal. The crop which ranked third in quality, F, was also raised with linseed meal with a smaller quantity of potash. The yield of wrappers was above the average of the plots which received equivalent quantities of cotton seed meal or castor pomace, and amounted to 842 lbs. per acre.

Fish as a Fertilizer for Tobacco.

We merely call attention to the plots T and Z. T received nitrogen in form of dry fish scrap and nitrate of soda with no potash. Z received nitrogen in dry fish alone. Z was one of the plots which suffered most from the drought, and evidently no conclusions are justified from this year's crop.

Effect of Nitrate of Soda at the First and Second Cultivation.

(Plots I and J compared with H).

The point of this experiment is to ascertain the effect on the crop of supplying one-third of the nitrogen of a heavy application (210 pounds), as a top dressing in the form of nitrate of soda in one application at the time of the first cultivation (Plot I) or in two applications at the time of the first and second cultivation (Plot J). In 1892 the effect in both cases was decidedly injurious on the quality of the wrappers, though Plot J yielded 180 lbs. more of wrappers than H. In 1893 J yielded 165 lbs. more wrappers than H, and the quality of the wrappers was even better. Plot I, which received all the nitrate in one application, produced less tobacco and of inferior quality.

Effect of the Different Forms of Potash.

(Plots A, K, L, M, N, O, P, Y).

Of the plots named, the best tobacco in 1893 came from the plot which had received wood ashes, Y, which ranked 10th. That raised with the double carbonate of potash and magnesia, P, and double sulphate of potash and magnesia without lime, K, ranked 14th and 15th. But that raised with an equivalent quantity of cotton hull ashes, A, carbonate of potash, O, double

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sulphate of potash and magnesia, *with lime*, L, and high grade sulphate *without* lime, M, were among the poorest lots in the field as regards quality.

As has been already stated conclusions are hardly possible where all the crops were so seriously injured by the drought.

EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS. SEASON OF 1894.

By E. H. Jenkins.

These experiments are in continuation of those begun in 1892 in cöoperation with the Connecticut Tobacco Experiment Co. of Poquonock in the town of Windsor.

Full particulars regarding the land, the conduct of the experiments and their results are given in the Report of this Station for 1892, pages 1 to 24, and Report for 1893, pages 112 to 144.

Fertilizers.

The stalks of the crop of 1893 were spread evenly on the plots and plowed in very early in the spring of 1894.

The fertilizers employed in 1894 were sampled and analyzed by Messrs. Winton and Ogden, with the following results:

Composition and Cost of Fertilizers Used.

	Cost Per Ton.	Nitrogen.	Phosphoric Acid.	Potash.
Nitrate of Soda	$50.00	16.00	----	----
Cotton Seed Meal	26.50	7.72	2.94	1.85
Castor Pomace	24.00	5.55	1.69	.90
Linseed Meal	27.00	5.75	1.77	1.28
Tobacco Stems	14.00	1.90*	.60*	8.10*
Cooper's Bone	27.00	1.60	29.20	----
Cotton Hull Ashes	45.00	----	7.04	20.1
Wood Ashes	12.00	----	1.00	3.69
High Grade Sulphate of Potash	55.00	----	----	47.44
Carbonate of Potash	170.00†	----	----	54.10
Double Carbonate Potash and Magnesia	39.00‡	----	----	18.10
Double Sulphate Potash and Magnesia	30.00	----	----	27.16
Fish	40.00	8.02	6.79	----

* Estimated. † By single pound; ton rates would be much lower.

‡ Total cost of importing a one ton lot from Stassfurt.

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The chemicals used for each plot were accurately weighed and labeled by the Station representative, mixed thoroughly and bagged by Mr. DuBon and himself.

The bags were carried to the several plots by Mr. DuBon, and their contents were sowed under his constant supervision.

The following table shows the plan of the experiment, the fertilizers applied, with the cost of each as far as known, and the quantities of nitrogen, phosphoric acid and potash contained in them. See pages 272 and 273.

The fertilizers were mixed and sown on May 11th and 12th. The plants were set, with a Bemis planter, on May 22d. The field superintendent, Mr. John A. DuBon, took entire care of the land and the crop, as he has done for the past three years. The crop was harvested on August 23d and 24th.

Notes on the Rainfall, Soil Moisture and Temperature. Season of 1894.

Through the coöperation of Prof. Milton Whitney, Chief of the Division of Agricultural Soils of the U. S. Department of Agriculture, who supplied the necessary instruments, daily observations were made by Mr. Adelbert DuBon during the growing season of maximum and minimum air temperature (radiation thermometers), maximum and minimum soil temperatures (average to depth of nine inches), and rainfall.

The instruments were placed near the crop on a plot which was kept free from all vegetation.

Samples of soil to the depth of nine inches were also daily drawn by Mr. DuBon from several plots and sent to the Station for determination of moisture.

The sampling apparatus and method of packing were designed by Prof. Whitney.

These observations taken together give a record of meteorological conditions which, however incomplete, is of great assistance in comparing the conditions under which the crops of successive years are raised.

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Linseed Meal	27.00	5.75	1.77	1.28
Tobacco Stems	14.00	1.90*	.60*	8.10*
Cooper's Bone	27.00	1.60	29.20	....
Cotton Hull Ashes	45.00	....	7.04	20.1
Wood Ashes	12.00	....	1.00	3.69
High Grade Sulphate of Potash	55.00	....	....	47.44
Carbonate of Potash	170.00†	....	....	54.10
Double Carbonate Potash and Magnesia	39.00‡	....	....	18.10
Double Sulphate Potash and Magnesia	30.00	....	....	27.16
Fish	40.00	8.02	6.79	....

* Estimated. † By single pound; ton rates would be much lower.

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These observations taken together give a record of meteorological conditions which, however incomplete, is of great assistance in comparing the conditions under which the crops of successive years are raised.

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Fertilizers Applied, Season of 1894.

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds.		
			Nitrogen.	Phosphoric Acid.	Potash.
A	1360 Cotton Seed Meal 1560 Cotton Hull Ashes	$53.12	105	150	339
B	1826 Linseed Meal 1572 Cotton Hull Ashes	60.02	105	143	339
C	2260 Cotton Seed Meal 1480 Cotton Hull Ashes	63.24	175	170	339
D	2720 Cotton Seed Meal 1440 Cotton Hull Ashes	68.44	210	180	340
E	1900 Castor Pomace 1640 Cotton Hull Ashes	59.70	105	148	347
F	1820 Linseed Meal 640 Cotton Hull Ashes 260 Cooper's Bone	42.48	105	153	152
G	3160 Castor Pomace 1540 Cotton Hull Ashes	72.52	175	162	338
H	3780 Castor Pomace 1520 Cotton Hull Ashes	79.56	210	171	340
I	1900 Castor Pomace 1640 Cotton Hull Ashes 320 Nitrate of Soda* 320 Nitrate of Soda†	75.70	208	148	347
J	1900 Castor Pomace 1640 Cotton Hull Ashes 640 Nitrate of Soda*	75.70	208	148	347
K	1360 Cotton Seed Meal 1160 Double Sulphate of Potash and Magnesia 380 Cooper's Bone	40.55	105	149	341
L	1360 Cotton Seed Meal 1160 Double Sulphate of Potash and Magnesia 380 Cooper's Bone 300 Lime	43.55	105	149	341
M	1360 Cotton Seed Meal 660 High Grade Sulphate of Potash 380 Cooper's Bone	41.30	105	149	338
N	1360 Cotton Seed Meal 660 High Grade Sulphate of Potash 380 Cooper's Bone 300 Lime	44.30	105	149	338

* Applied between the rows at time of first cultivation.

† Applied between the rows at time of second cultivation.

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FERTILIZERS APPLIED, SEASON OF 1894.

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds.		
			Nitrogen.	Phosphoric Acid.	Potash.
O	1360 Cotton Seed Meal 580 Carbonate of Potash 380 Cooper's Bone	$72.45	105	149	339
P	1360 Cotton Seed Meal 1740 Double Carbonate Potash and Magnesia 380 Cooper's Bone	57.08	105	149	340
Q	2000 Baker's A. A. Superphosphate 4000 Baker's Tobacco Manure	....	241	489	495
R	2000 Stockbridge Tobacco Manure 500 Stockbridge Tobacco Manure*	....	149	281	283
S	3000 Stockbridge Tobacco Manure 500 Stockbridge Tobacco Manure*	....	209	393	396
T	880 Dry Ground Fish 440 Nitrate of Soda 300 Lime	31.60	142	60	....
U	2200 Mapes' Tobacco Manure, Wrapper Brand 600 Mapes' Starter	....	158	211	278
V	2400 Mapes' Tobacco Manure, Wrapper Brand 400 Mapes' Starter	....	163	196	294
W	2400 Mapes' Tobacco Manure, Wrapper Brand	....	151	143	280
X	2000 Sanderson's Formula for Tobacco	....	103	281	105
Y	1360 Cotton Seed Meal 8540 Wood Ashes 80 Cooper's Bone	70.34	105	147	340
Z	1300 Dry Ground Fish 1260 Double Sulphate of Potash and Magnesia 200 Cooper's Bone	47.60	104	146	342
AA	Stable Manure 10–12 cords† On half the plot Swift Sure Superphosphate as a starter, at rate of 500 pounds per acre.	....	125	143	171
BB	6000 Tobacco Stems 2640 Castor Pomace On half the plot, Swift Sure Superphosphate as a starter, at rate of 500 pounds per acre	83.18	253	146	539
CC	3000 Pinney's Formula Fertilizer	....	131	196	305

* Applied as a starter.

† Estimated to contain 111 lbs. nitrogen, 71 lbs. phosphoric acid and 149 lbs. potash.

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Rainfall in 1894.

The tobacco was set on May 22d and harvested on Aug. 13th and 14th, and was in the field, therefore, 83 days. The rainfall was as follows:—

May 23.....37 inch.	June 19.....04 inch.	July 16.....16 inch.
" 24.....47 "	" 20.....09 "	" 23.....12 "
" 25.....12 "	July 1.....54 "	" 29.....26 "
" 29.....62 "	" 4.....20 "	Aug. 3...2.45 "
" 31.....24 "	" 7.....10 "	" 9.....08 "
June 3.....57 "	" 14.....73 "	

Total, 7.16 inches.

June was a very dry month. The rainfall from June 3d to to July 1st was only .13 inch, and no rain at all fell from the 3d till the 19th of June.

Yet daily reports from the field marked the conditions "favorable" till June 28th, when the soil was called "too dry." The store of moisture in the soil was by that time so depleted by the hot, dry weather and the demands of the quickly growing crop that frequent showers were needed. The soil is reported "too dry" on the following days:—June 28th to 30th, July 7th, 10th to 13th, 27th to Aug. 2d; fifteen days in all.

Some crops in the same town suffered severely from drought. No marked signs of damage appeared in the experiment field, though the yield would have been larger if there had been more rain. The distribution of the rainfall is of great importance, as well as the total amount. Thus if the heavy rain of August 3d had fallen in two portions during June, it would have materially improved the crop.

The Percentage Amount of Water in the Soil.

Daily determinations of moisture in the soil, taken to the depth of 8 inches, were made on five different plots of the field, as follows:—

Plot 1 had lain unfertilized and untilled for ten years. In 1894 it was plowed and kept free from vegetation and the soil surface was occasionally stirred by raking.

Plot 2 differed from plot 1 only in having an application of linseed meal and cotton hull ashes at the rate of 1500 pounds per acre of each.

Plot 3 in like manner received dry ground fish and double sulphate of potash at the rate of 1500 pounds of each per acre.

Plots F and Y were planted with tobacco, the former dressed with 1760 lbs. to the acre of Linseed Meal, 660 of Cotton Hull Ashes and 260 lbs. of Cooper's Bone. Plot Y was dressed with

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1500 lbs. Cotton Seed Meal, 5620 lbs. unleached wood ashes and 160 lbs. Cooper's bone per acre. The samples of soil on the two plots Y and F were always drawn in the row, never between the rows. For comparison are also given determinations of moisture daily made in samples of soil from the tobacco field of Mr. Addison Lamphear, of Poquonock. These samples Mr. Lamphear had the kindness to draw and mail to the Station through the season gratuitously. This field is some fifty feet lower than the experiment field, lies in a bend of the Farmington river, and is believed to be a river deposit, but its texture is not very different from that of the experiment field and the quality and color of leaf raised on it are not very different.

In the following table are given the average per cents. of water found in the soils for each week, calculated from daily determinations.

AVERAGE MOISTURE CONTENT OF SOIL BY WEEKS.

	Plots bare of Vegetation.			Plots planted to Tobacco.		
Plots	1	2	3	F	Y	A. Lamphear's.
June 10 to June 16	7.7	7.9	7.9	12.1	7.7	--
" 17 " 23	7.4	7.4	7.6	11.1	7.2	8.1
" 24 " 30	6.9	7.3	7.3	10.3	6.1	7.5
July 1 to July 7	7.3	8.0	7.6	8.9	8.3	7.5
" 8 " 14	7.5	7.7	7.5	8.4	6.2	7.0
" 15 " 21	7.7	8.0	8.1	6.6	6.0	7.5
" 22 " 28	7.7	8.0	7.9	6.6	5.4	6.5
" 29 to Aug. 4	7.5	7.7	7.9	7.5	4.3	7.3
Aug. 5 " 11	8.0	8.3	7.9	9.2	7.5	7.4
Average	7.52	7.81	7.74			

Examination of the first three columns shows that neither fertilizer had any pronounced effect in controlling the amount of water contained in the soil.

The average per cents. of moisture in the soil (to the depth named) for the growing season on plots 1, 2 and 3 were 7.5, 7.8 and 7.7 respectively.

It also appears that for some reason the soil of plot F contained considerably more moisture than either of the other plots all through the season.

Comparison of the per cent. of water in the soil of plots F and Y with the per cent. of water in the soil of the three unplanted plots shows the exhaustion of the soil water by the growing crop.

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Thus until July 7, the per cents. of water in the soils of plots I and Y are not very unlike, but from there on, plot Y on which the crop was growing, held much less water than plot 1, which was bare of vegetation.

On June 19th samples of soil were carefully drawn from each plot in the field, to ascertain whether there was any striking difference in the water content of the several plots, and if so whether this could be connected with the fertilizers applied.

The diagram on the next page presents the results:—

The lowest water-content in any plot planted to tobacco was 6.5 per cent., the highest, 12.4.

The dampest soils were those of U, F, Q and T. The dryest soils were those of B, CC and X.

There is no apparent connection between the amount of moisture and the nature of the fertilizer.

There are two places in the field which are damper than the rest, one covering plots J, T, V, U, Q and F, the other covering E, A, M, N, K, H.

The first named spot was sometimes marked by a damper look of the soil after the ground was rowed out and before the crop had fairly started; the latter was never noticeable.

These spots cannot be accounted for by the "lay of the land" simply. There is no apparent reason for the difference in moisture.

Whether this difference is sufficient to affect in any way the quality of the tobacco grown on the several plots is a question which requires further study.

Temperature of Air and Soil.

Daily observations of temperature were made, as already described by Mr. Adelbert DuBon.

In a following table are given the average weekly maxima, minima and ranges of temperature.

Accidents to the minimum radiation thermometer make Mr. DuBon's record deficient.

Similar observations were made by Mr. Addison Lamphear on his own tobacco field, above described from June 17 to Aug. 18, and these are included in the table, being distinguished from those of Mr. DuBon by full-face type.

It appears that the maximum and minimum air temperatures in Mr. Lamphear's field were somewhat higher than on the experiment field. There is a very striking difference in the soil temper-

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THE EXPERIMENT TOBACCO FIELD, POQUONOCK, CONN.,
SHOWING PER CENT. OF MOISTURE IN THE
SEVERAL PLOTS ON JUNE 19, 1894.

			DD —	BB 8.9	AA 9.1
			CC 6.6	Z 8.2	Y 7.7
H 9.8	D 8.2	Q 7.7	C 7.3	F 11.8	B 6.5
K 10.1	L 8.8	O 8.7	P 8.3	Q 10.9	X 6.9
N 9.3	M 9.2	R 8.6	S 8.9	U 12.4	V 9.0 W 7.4
A 9.3	E 9.6	I 8.6	J 9.3	T 10.5	

C 7.2 | B 7.3 | A 7.6

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ature of the two fields. The maximum soil temperatures are much lower, and the minimum soil temperatures are much higher on Mr. Lamphear's field than on the other. It follows that his soil had a much more equable temperature than the other, it transmitted heat much more slowly. To what this is due has not been determined. It seems quite possible, however, that such differences might have a very decided effect on the growth and quality of the crop.

AIR AND SOIL TEMPERATURE AT THE EXPERIMENT TOBACCO FIELD.
WEEKLY AVERAGES.

	Radiation Thermometer.			Soil Temperature.		
	Max.	Min.	Range.	Max.	Min.	Range.
June 3- 9.....	79.5	58.7	20.8	70.3	63.6	6.7
10-16.....	94.8	....	....	81.5	71.2	10.3
17-23.....	98.0	....	....	84.9	76.8	8.1
	98.7	**60.6**	**38.1**	**82.3**	**77.5**	**4.8**
24-30.....	90.7	....	....	83.9	72.3	11.6
	92.5	**63.2**	**29.3**	**77.2**	**75.2**	**2.0**
July 1- 7.....	92.5	58.2	34.3	89.9	68.4	21.5
	95.7	**58.4**	**37.3**	**83.3**	**75.3**	**8.0**
8-14.....	90.3	53.3	37.0	85.9	64.1	21.8
	95.8	**50.4**	**45.4**	**77.2**	**73.5**	**3.7**
15-21.....	97.0	54.4	32.6	92.1	68.8	23.3
	101.8	**59.8**	**42.0**	**83.7**	**74.9**	**8.8**
22-28.....	94.2	51.5	42.7	87.6	65.6	22.0
	96.0	**59.2**	**36.8**	**79.2**	**72.4**	**6.8**
29-Aug. 4.	94.8	54.1	40.7	89.8	72.4	17.4
	96.4	**61.1**	**35.3**	**80.3**	**75.1**	**5.2**
Aug. 5-11	91.3	....	....	86.3	66.5	19.8
	93.4	**51.4**	**42.0**	**75.2**	**70.5**	**4.7**
12-18.....	86.6	....	....	83.0	62.7	20 3

The highest temperature recorded in the experiment field by the radiation thermometer was 111° Fahr., the lowest 39½°.

The highest record of the soil thermometer was 97.9, the lowest 53.1° F.

HARVESTING, CURING, STRIPPING AND SORTING.

On August 13th and 14th the crop was harvested. The method of harvest, stringing and hanging has already been described in the Report for 1893, p. 138.

The weather was favorable for curing and on Oct. 24th the crop was taken down from the poles, stripped and bundled, the crop of each plot by itself. The crops were sorted by Mr. DuBon from Nov. 17th to 22d.

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As the crops were sorted, samples were carefully drawn from each lot of long and short wrappers as described in the Report for 1893, p. 138.

These samples were for laboratory examinations and for fermentation.

The following table gives the results of the sorting. The weights are in pounds. For those unfamiliar with the details of sorting leaf-tobacco, it may be said that the "seconds" are the lower leaves on the stalk, smaller than those of either of the other grades, over-ripe and unfit for wrappers. The "long wrappers" and "short wrappers" are the most valuable part of the crop, the latter being smaller and lighter, and often cutting to greater advantage than "long wrappers." The "top leaves" are often as large as the long wrappers, but heavier, darker in color and unripe.

WEIGHT OF POLE-CURED LEAVES FROM $\frac{1}{10}$ ACRE.
CROP OF 1894.

Plot.	Long Wrappers.	Short Wrappers.	Top Leaves.	Seconds.	Net Weight of Sorted Tobacco.
A	37	11½	12	21½	82
B	34½	10½	10½	18	73½
C	44	13	10½	12½	80
D	52½	14	12	14	92½
E	35½	12	14½	22	84
F	41	13	12	16	82
G	43	14	11½	16	84½
H	52½	14	12	15	93½
I	46	12½	16	18	92½
J	49	13	14	18	94
K	46½	11½	14½	17½	90½
L	38	13½	12	17	80½
M	34	10½	16½	23	84
N	36	11	15½	22½	85
O	39	12	13½	11	75½
P	33	11	10	16½	70½
Q	46	9½	15½	21½	92½
R	36½	11½	16½	14½	79
S	45½	12½	15	15½	88½
T	37	8	23½	23½	92
U	55½	9	14	20½	105½
V	43½	11½	12½	15½	83½
W	49½	13½	13½	10½	78
X	34	12	12	17	75
Y	42	10	10½	14	76½
Z	33½	12½	12½	14½	73½
AA	19	9	12½	23½	63½
BB	30	9	18	19½	76½
CC	31	11½	16	12½	71

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PER CENT. OF THE FOUR DIFFERENT GRADES.

POLE-CURED CROP OF 1894.

Plot.	Long Wrappers.	Short Wrappers.	Total per cent. of Wrappers.	Tops.	Seconds.
A	45.1	14.0	59.1	14.7	26.2
B	46.9	13.9	60.8	14.6	24.6
C	55.0	16.2	71.2	13.1	15.7
D	56.7	15.2	71.9	12.9	15.2
E	42.3	14.3	56.6	17.3	26.1
F	50.0	15.8	65.8	14.6	19.6
G	50.9	16.5	67.4	13.6	19.0
H	56.1	14.9	71.0	12.8	16.2
I	49.7	13.5	63.2	17.3	19.5
J	52.1	13.9	66.0	14.9	19.1
K	51.5	12.5	64.0	16.3	19.7
L	47.2	16.7	63.9	14.9	21.2
M	40.4	12.5	52.9	19.6	27.5
N	42.3	12.9	55.2	18.2	26.6
O	51.7	15.9	67.6	17.9	14.5
P	46.8	15.6	62.4	14.1	23.5
Q	49.7	10.3	60.0	16.7	23.3
R	46.2	14.6	60.8	20.9	18.3
S	51.4	14.1	65.5	17.0	17.5
T	40.2	8.8	49.0	25.5	25.5
U	52.5	8.5	61.0	19.9	19.1
V	52.2	13.5	65.7	15.3	19.0
W	51.9	17.3	69.2	17.3	13.5
X	45.3	16.0	61.3	16.0	22.7
Y	54.8	13.0	67.8	13.7	18.5
Z	45.7	17.1	62.8	17.1	20.1
AA	29.9	14.1	44.0	19.3	36.7
BB	39.1	11.7	50.8	23.5	25.7
CC	43.7	16.2	59.9	22.5	17.6

COMPARATIVE FIRE-HOLDING CAPACITY.

POLE-CURED CROP OF 1894.

The method of determining the fire-holding capacity is described in the Station Report for 1892, page 17.

The lot which held fire for the shortest time is marked 100. The others are marked higher and according to their relative fire-holding capacity. Thus of the long wrappers, lot Q is marked 100 as it had a lower fire-holding capacity than any other. Lot A has about 2⅛ (218) times the fire-holding capacity of lot Q.

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	Long Wrappers.	Short Wrappers.	Calculated from the Average of both.
A	218	247	218
B	207	223	201
C	224	245	220
D	201	258	217
E	223	146	167
F	134	166	142
G	204	181	177
H	245	226	218
I	130	265	192
J	283	267	255
K	215	100	139
L	132	133	123
M	154	158	146
N	196	183	175
O	241	214	210
P	314	236	251
Q	100	113	100
R	166	227	187
S	128	182	148
T	133	138	126
U	121	178	142
V	146	164	145
W	217	141	162
X	126	126	117
Y	235	349	279
Z	150	252	193
AA	151	156	143
BB	169	214	180
CC	186	202	181

NUMBER OF POLE-CURED LEAVES TO THE POUND.

CROP OF 1894.

	Long Wrappers.	Short Wrappers.		Long Wrappers.	Short Wrappers.
A	67	92	P	69	94
B	74	93	Q	67	90
C	65	87	R	53	103
D	55	86	S	65	91
E	67	94	T	60	87
F	66	91	U	59	81
G	60	80	V	62	84
H	65	83	W	73	93
I	68	88	X	64	89
J	69	88	Y	59	90
K	63	94	Z	67	88
L	62	81	AA	66	77
M	72	87	BB	59	81
N	67	97	CC	56	81
O	70	94			

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Discussion of the Results.

The following paragraphs notice the principal features in the results of this year's experiments. The present plan is not to attempt any general conclusions till five successive crops have been raised, cured and fermented.

Net Weight of the Sorted Crops, 1894.

In 1892 there was harvested from 23 plots of $\frac{1}{20}$ acre each, 2122 pounds of sorted tobacco, or at the rate of 1845 pounds per acre.

In 1893 there was harvested from 28 plots 2183 pounds, or at the rate of 1559 pounds per acre.

In 1894 there was harvested from 28 plots, 2399¼ pounds of sorted tobacco, or at the rate of 1713 pounds per acre.

The crop of 1892 contained 66.7 per cent. of wrappers. The crop of 1893 contained 48.5 per cent. of wrappers, and the crop of 1894, 62.1 per cent. of wrappers.

The maximum yield in 1894 was on plot U, at the rate of 2115 lbs. of sorted tobacco per acre, of which 1290 pounds were wrappers. The maximum yield of wrappers was on plots D and H, (1860 pounds sorted tobacco, 1330 pounds wrappers.) Plots H, D, I and Q, all yielded from 1870 to 1850 pounds of sorted tobacco, with 1330, 1330, 1170 and 1110 pounds of wrappers respectively.

The smallest crops were on plots P, CC, Z and B and were respectively, 1410, 1420, 1465 and 1470 pounds of sorted tobacco. The weights of wrappers were respectively 880, 841, 920, 895 pounds.

Cotton Seed Meal and Castor Pomace. (Plots A, C, D, compared with E, G, H.)

The yield of sorted tobacco from the cotton seed meal plots averaged 1696 pounds per acre. The yield from the plots which received castor pomace in quantity equivalent to the cotton seed meal averaged 1746 pounds. The yield of wrappers grown on cotton seed meal averaged 1146 pounds, grown on castor pomace the average was 1140 pounds. The yield of the cotton seed plots and castor pomace plots are therefore practically identical.

Increasing the quantity of cotton seed meal in the fertilizer from 1360 to 2260 pounds per acre did not increase the yield, but a further increase of 500 pounds per acre made an increase of

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250 pounds per acre in the sorted tobacco. The quantity of wrappers increased regularly with the increase in the quantity of cotton seed meal or castor pomace applied. These facts are shown in the following table, expressed in pounds per acre.

Cotton Seed Meal in fertilizers.	Sorted Tobacco.	Wrappers.	Castor Pomace in fertilizers.	Sorted Tobacco.	Wrappers.
1360	1640	970	1900	1680	950
2260	1600	1140	3160	1690	1140
2720	1850	1330	3780	1870	1330

Nitrate of Soda with Castor Pomace. Where for an application of 210 pounds of nitrogen, as on plot H, was substituted half that quantity of nitrogen in pomace and the other half in nitrate of soda, plots I and J, the yield was practically the same in all cases, the extreme difference of sorted tobacco being only 30 pounds per acre.

The yield of wrappers however was greatest where castor pomace alone was used, plot H, 1330 pounds, and least where half the nitrate was applied at planting and half later in the season, plot I, 1170 pounds.

Potash Salts. Of the various potash salts, the double sulphate of potash and magnesia, K, yielded the largest crop (1805 pounds) and the largest quantity of wrappers (1155 pounds). This was also true of the crops of 1892 and 1893.

When lime was used with the double sulphate L, both the total yield and the yield of wrappers was considerably smaller.

Plots L, Y, and O, to which double sulphate of potash and magnesia with lime, wood ashes, and carbonate of potash were respectively applied, yielded about 1030 pounds of wrappers each. Next rank A, cotton hull ashes, 970 pounds, N, high grade sulphate of potash with lime, 940 pounds, and M, high grade sulphate of potash and P, carbonate of potash and magnesia, which yielded each 880 pounds of wrappers.

Linseed Meal. Plot B, which received linseed meal in place of cotton seed meal, yielded 180 pounds less of crop and 75 pounds less of wrappers than A which was dressed with cotton seed meal.

But plot F which received the same quantity of linseed meal as B but less than half the quantity of cotton hull ashes yielded the same quantity of tobacco as A and 110 pounds more of wrappers.

Fish. Plot Z received its nitrogen in form of fish and is comparable with plot K on which an equivalent amount of cotton seed meal was used.

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Plot Z produced 340 pounds less of tobacco than K and 235 pounds less of wrappers.

Stems and Stable Manure. Plot AA which was dressed with stable manure and BB which was dressed with tobacco stems and castor pomace produced less tobacco than most of the other plots and the least wrappers of any plots.

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STATE OF CONNECTICUT

NINETEENTH ANNUAL REPORT

— OF —

The Connecticut Agricultural Experiment Station

For 1895

Printed by Order of the General Assembly

The publications of this Station are sent free to every citizen of Connecticut who applies for them. Address, The Conn. Agricultural Experiment Station, New Haven, Conn.

NEW HAVEN:
THE TUTTLE, MOREHOUSE & TAYLOR PRESS
1896

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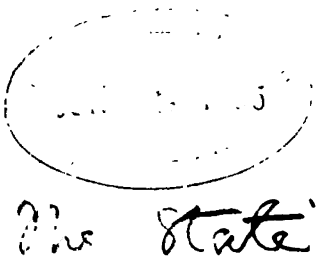

CORRECTIONS.

Page 5. Among firms who have paid analysis fees to May 1, 1896 insert,

Danbury Fertilizer Co., Danbury, Conn.	Bone Meal. Nameless Fertilizer. Potato Manure.

Page 16. Fourth line from top, insert organic, before the word nitrogen and in the same line, for 18½, read 16½.

Page 41. The valuation of Sanderson's Old Reliable Phosphate, analysis No. 4800, should be $23.28 instead of $26.79, and the percentage difference, 28.8 instead of 11.9.

Page 102. Thirteenth line from top, for 11.4 read 13.4.

Page 105, pot No. 117. For weight of water-free Maize crop, read 141.58 instead of 145.58.

Page 146, in the table of Composition of Fertilizers, the per cent. of potash in cotton hull ashes should read 24.11 instead of 2.41.

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CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

OFFICERS AND STAFF FOR 1895.

STATE BOARD OF CONTROL.

Ex-officio.

HIS EXCELLENCY O. VINCENT COFFIN, *President.*

	Term expires,
Appointed by Connecticut State Agricultural Society:	
HON. E. H. HYDE, Stafford, *Vice-President.*	July 1, 1897
Appointed by Board of Trustees of Wesleyan University:	
PROF. W. O. ATWATER, Middletown.	1897
Appointed by Governor and Senate:	
EDWIN HOYT, New Canaan.	1898
JAMES H. WEBB, Hamden.	1896
Appointed by Board of Agriculture:	
T. S. GOLD, West Cornwall.	1898
Appointed by Governing Board of Sheffield Scientific School:	
W. H. BREWER, New Haven, *Secretary and Treasurer.*	1896
Ex-officio.	
S. W. JOHNSON, New Haven, *Director.*	

Executive Committee.

STATION STAFF.

Chemists.

S. W. JOHNSON, *Director.*
E. H. JENKINS, PH.D., *Vice-Dir.*
A. L. WINTON, PH.B.
T. B. OSBORNE, PH.D.
A. W. OGDEN, PH.B.
G. F. CAMPBELL, PH.B.

Mycologist.

WILLIAM C. STURGIS, PH.D.

Horticulturist.

W. E. BRITTON, B.S.

Grass Gardener.

JAMES B. OLCOTT, South Manchester.

Stenographer and Clerk.

MISS C. S. GREEN.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helpers.

HUGO LANGE.
JULIUS KORN.

Sampling Agents.

C. L. BACKUS, Andover.
M. H. PARKER, So. Coventry.

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Notice as to Bulletins.

The Bulletins of this Station are mailed free to citizens of Connecticut who apply for them, and to others, as far as the limited editions permit.

Applications should be renewed annually before January 1st.

The matter of all the Bulletins of this Station, in so far as it is new or of permanent value, will be made part of the Annual Report of the Station Staff.

All Bulletins earlier than No. 71 and Nos. 83, 93, 101, 102 and 118 are exhausted and cannot be supplied.

Notice as to Supply of Station Reports.

The Station has no supply of its Annual Reports for the years 1877, 1878, 1879, 1880, 1881, 1882, 1883, 1887, 1891 and 1893.

The Annual Report of this Station, printed at State expense, is by law limited to an edition of 12,000 copies, of which 5,000 copies are bound with the Annual Report of the Connecticut State Board of Agriculture, and distributed by the Secretary of the Board, T. S. Gold, West Cornwall, Conn.

After exchanging with other Experiment Stations and Agricultural Journals, the Reports remaining at the disposal of the Station will be sent to citizens of Connecticut who shall seasonably apply for them, and to others as long as the supply lasts.

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ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, moulds, blights, mildews, useful or injurious insects, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station does not undertake sanitary analyses of water.

The Station makes analyses of Fertilizers, Seed-Tests, etc., for the citizens of Connecticut, without charge, provided—

1. That the results are of use to the public and are free to publish.

2. That the samples are taken from stock now in the market, and in accordance with the Station "Instructions for Sampling."

3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs, and like Associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.

☞ By a recent Act of Legislature it is made the business of this Station to examine articles of food and drink on sale in Connecticut, with reference to their adulterations.

Here it may be stated that, *until further notice*, the Station will examine only such samples of food and drink as are collected by its agents or such as shall be taken under its advice, and by the methods it shall prescribe or approve.

All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the private use of individuals is charged for at moderate rates. The Station

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undertakes no work, the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of immediate general interest are published in Bulletins, copies of which are sent to each Post Office in this State, and to every citizen of the State who applies for them. The results of all the work of the Station are summed up in the Annual Reports made to the Governor.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

☞ Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties, sent on application.

☞ Parcels by Express, to receive attention should be *prepaid*.

☞ Letters sent to individual officers are liable to remain unanswered in case the officer addressed is absent. All communications on Station business that requires immediate attention, therefore, should be directed simply to the

AGRICULTURAL EXPERIMENT STATION,

NEW HAVEN, CONN.,

and all remittances should be made payable to the undersigned.

☞ Station Grounds, Laboratories and Office are on Suburban st., five minutes walk west from Whitney avenue and 1¼ miles north of City Hall.

☞ Suburban st. may be reached by Whitney ave. Electric Cars, which leave the corner of Chapel and Church sts., five times hourly, viz: on the striking of the clock and at intervals of twelve minutes thereafter.

☞ The Station may also be reached by taking Winchester ave. Electric Cars, going north, which pass the Union R. R. Depot, and also start from corner Chapel and Church sts., at intervals of sixteen minutes. Get off at Harriet st., whence five minutes walk eastward, crossing Prospect st., and entering Suburban st. brings to the Station.

☞ The Station has Telephone connection and may be spoken from the Central Telephone Office, 118 Court st., or from Peck & Bishop's Office in Union R. R. Depot, New Haven.

☞ The Grass Garden, in charge of Mr. James B. Olcott, is near South Manchester, two minutes walk from the line of the Manchester Electric Cars, leaving City Hall square, State st., Hartford, every half hour. Conductors on this line can direct visitors to the Garden.

S. W. JOHNSON, *Director*.

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REPORT OF THE TREASURER.

WM. H. BREWER, IN ACCOUNT WITH THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION FOR THE FISCAL YEAR ENDING SEPTEMBER 30TH, 1895.

RECEIPTS.

	Oct. 1894 to June 1895.	July to Sept. 1895.	Total.
State Appropriation	$6,000.00	$2,500.00	$8,500.00
United States Appropriation	5,625.00	1,875.00	7,500.00
Analysis Fees due last fiscal year	617.96	----------	617.96
Analysis Fees due this fiscal year	4,507.07	1,504.93	6,012.00
Miscellaneous Receipts	113.11	----------	113.11
Balance from last account	18.13	----------	18.13
Total Receipts	$16,881.27	$5,879.93	$22,761.20

EXPENDITURES.

	State Acc't.	U. S. Acc't.	Total.
Salaries*	$5,563.00	$5,600.00	$11,163.00
" †	1,897.50	1,875.00	3,772.50
Labor*	549.80	----------	549.80
" †	28.05	----------	28.05
Publications*	210.56	----------	210.56
" †	106.93	----------	106.93
Postage*	94.22	----------	94.22
" †	45.10	----------	45.10
Stationery*	68.83	----------	68.83
" †	42.90	----------	42.90
Freight and Express*	63.44	----------	63.44
" " †	15.82	----------	15.82
Coal*	554.05	----------	554.05
Gas*	239.29	----------	239.29
" †	46.75	----------	46.75
Water*	147.00	----------	147.00
Chemicals*	156.58	----------	156.58
" †	295.93	----------	295.93
Laboratory Supplies*	58.63	----------	58.63
" " †	41.28	----------	41.28
Agricultural Supplies*	51.90	----------	51.90
" " †	12.00	----------	12.00
Horticultural Supplies*	4.50	----------	4.50
" " †	21.65	----------	21.65
Botanical Supplies*	5.64	----------	5.64
" " †	14.28	----------	14.28

* For the 9 months, October 1st, 1894, to June 30th, 1895.

† For the 3 months, July 1st to September 30th, 1895.

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	State Acc't.	U. S. Acc't.	Total.
Miscellaneous Supplies*	$58.87		$58.87
" " †	8.07		8.07
Fertilizers*	128.50		128.50
Feeding Stuffs*	80.90		80.90
" " †	24.79		24.79
Library*	378.52	$10.00	388.52
" †	115.83		115.83
Tools and Machinery*	18.35		18.35
" " †	24.70		24.70
Furniture and Fixtures*	24.71		24.71
" " †	46.30		46.30
Scientific Apparatus*	318.89	15.00	333.89
" " †	138.23		138.23
Live Stock*	140.00		140.00
Traveling Expenses of the Board*	5.65		5.65
" " " " †	38.77		38.77
" " " Staff, dairy Exp.*	28.80		28.80
" " " Tobacco Exp.*	63.75		63.75
" " " " †	24.54		24.54
" " " Field Exp.*	26.55		26.55
" " " " †	25.40		25.40
" " " Miscel. Work*	183.06		183.06
" " " " †	12.35		12.35
" " " Sampling Fer.*	234.99		234.99
" " " " †	3.45		3.45
Telephone*	147.42		147.42
" †	11.60		11.60
Tobacco Investigation*	140.43		140.43
" " †	286.72		286.72
Grass Investigation*	50.00		50.00
Field Experiments†	38.50		38.50
Miscellaneous Sundries*	50.67		50.67
" " †	52.20		52.20
Food Sampling†	11.74		11.74
New Buildings*	1,013.80		1,013.80
" " †	403.66		403.66
Betterments*	135.65		135.65
Repairs*	220.82		220.82
" †	208.39		208.39
	$15,261.20	$7,500.00	$22,761.20

The accounts of the treasurer were duly audited by the State Auditors of Public Accounts, on September 13th, for the first nine months, and for the remaining three months on December 3d, and after rendering the report for the United States fiscal year, the books of the treasurer were examined by an agent of the Secretary of Agriculture.

By Act of Congress, the Experiment Stations receiving appropriations from the United States are required to make treasurer's

* For the 9 months, October 1st, 1894, to June 30th, 1895.

† For the 3 months, July 1st to September 30th, 1895.

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reports annually to the Secretary of Agriculture as to how the money received from that source has been expended, which reports are to be in accordance with a schedule prepared by the said Secretary and for the fiscal year of the United States. The Secretary of Agriculture makes the reasonable request that all the Stations having other sources of income, keep their books in accordance with the before mentioned schedule and furnish him with a full treasurer's report of the Station's total receipts and expenses.

In complying with above requirement and request, it is necessary that the treasurer of this Station make two different annual reports, one to the United States Secretary of Agriculture and covering the United States fiscal year ending June 30th, and the other for the State fiscal year ending September 30th.

If the two reports of receipts and expenditures give the amounts for the respective years only as a whole, it is obvious that the figures in these reports will differ both in their totals and in their details, and consequently that their comparison and agreement could only be made by a study of the original books. The treasurer has therefore given in each report the figures for the nine months and the three months respectively, in order that their correlation and comparison may be easily made.

WM. H. BREWER, *Treasurer.*

Dec. 13th, 1895.

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REPORT OF THE BOARD OF CONTROL.

To His Excellency, O. Vincent Coffin, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station herewith submits its report for the year ending October 31st, 1895.

LEGISLATION AFFECTING THE STATION.

The General Assembly at the January session, 1895, passed an Act making an appropriation to the Connecticut Agricultural Experiment Station, which added $2,000 to the annual appropriation made by the State, and provided besides the sum of $2,500 for better equipping and making additions to the laboratories, and for other specified objects.

The General Assembly also passed an Act regulating the manufacture and sale of food products which appropriated $2,500 annually to this Station, to execute the provisions of the law.

Copies of these acts will be printed with the Report of the Station staff, which is now in preparation.

EXAMINATION OF FOOD PRODUCTS.

Although the appropriation made in the Pure Food Bill does not become available until the first of November, 1895, the work of preparing for the execution of the law and of collecting and examining samples of food was early begun.

Nineteen samples of molasses, sixteen of sugar, twenty-one of maple syrup, eighteen of strained honey, forty-one of lard and forty of spices have been collected and examined or are in process of examination. The results of this work will be discussed in the Report on Foods, which will form part of the 20th annual Report of this Station for the year 1896.

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The Fertilizer Control.

During the months of April, May and June, Messrs. C. L. Backus, of Andover, and M. H. Parker, of Coventry, agents of this Station, visited one hundred and six towns and villages, to inspect commercial fertilizers, and drew five hundred and fifty-five samples, representing one hundred and ninety-nine brands of commercial fertilizers.

Analyses of all these brands have been made in duplicate in the chemical laboratory by Messrs. Winton and Ogden, with the assistance of Mr. Lange, and manuscript copies of each analysis have been sent to the manufacturer and to the dealers.

No fraudulent fertilizers have been found in the State this year. A small number, of very inferior value, are annually offered, but usually disappear from the market after their analyses have been published.

The Work of the Chemical Laboratory.

Besides the work of analyzing food and of the fertilizer control just mentioned, Messrs. Winton and Ogden, with Mr. Lange's help, have analyzed two hundred and eight commercial fertilizers and manurial waste products, making the whole number of fertilizer analyses four hundred and seven.

To supplement horticultural work done by Mr. Britton, they have analyzed eight samples of lettuce, five of tomato vines, eight of tomato fruit, one of soil, one of chemicals, and one hundred and thirty-seven of crops grown in vegetation pots.

In connection with Station field experiments they have analyzed six samples of cow-pea plants, eighteen of potatoes, eight of corn and corn stover, and one hundred and sixteen of leaf tobacco.

Thirteen samples of feeds, one of vinegar, five of poultry feeds and fourteen of milk, have been analyzed in response to requests from citizens of the State. No record has been kept of the considerable number of determinations of fat in cream and milk, made for creameries, milk dealers and consumers. Fifteen determinations of nitric acid in soil decoctions were also executed.

Forty-eight samples of butter and molasses have been examined for the State Dairy Commissioner.

In connection with the tobacco experiment at Poquonock, daily determinations of moisture were made in the soil of the tobacco field, during the tobacco-growing season. The total number of determinations amounted to one hundred and forty-seven.

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Two hundred and eighteen samples of seeds have been tested with regard to vitality by the laboratory staff.

A very considerable number of determinations have also been made in testing methods, on samples submitted by the Association of Official Agricultural Chemists, and in the preparation of a paper by Mr. Winton, on "Some Conditions Affecting the Accuracy of the Determination of Potash," published in the American Chemical Journal, Vol. XVII, No. 6.

Exclusive of these last mentioned, the total number of analyses made in the chemical laboratory during the year is eleven hundred and seventy-one.

Studies on the Vegetable Proteids.

The work done by Dr. Osborne, with the assistance of Mr. Campbell, may be summarized as follows:

The investigation of diastase, the sugar-forming ferment of sprouting seeds, has been continued and the results obtained are ready for the printer.

A study of the proteids of the potato has been completed.

The proteids of malt have been investigated and the changes of the proteids occurring during germination shown by a comparison with those of ungerminated barley investigated last year.

The proteid substances, described under the name conglutin, the chief nitrogenous constituents of a large number of cattle foods, have been investigated and the conflicting statements of earlier investigators have been cleared up. In this work the seeds of the peach, almond, walnut and hazel nut, have also been studied. These seeds, together with those already examined in this laboratory, have afforded a complete review of the subject of conglutin.

A similar study of the proteid at present known as legumin has been commenced and is well under way, several of the leguminous seeds having been already studied.

The Work of the Mycologist.

Dr. Sturgis, with the aid of Mr. W. H. Olcott at South Manchester, has carried out a field experiment to study the efficacy of the corrosive sublimate treatment of potato seed, where the land which is planted to potatoes is already fully infested with the potato-scab fungus.

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In the same experiment the effect on the prevalence of this disease, of application of lime and of stable manure both fresh and composted, has been noted. This work is supplementary to that done last year on the same subject.

A field experiment on the land of Mr. Buckingham, of Southport, and a much smaller one on the Station grounds, have been made to determine how far transplanting onions (on smutty land) is practicable as a means of preventing smut, increasing the yield and hastening maturity.

An experiment on spraying apple trees has been made at Shaker Station.

Much time has also been spent in studies on a blight of melons which has been very destructive in some parts of the State, on a leaf-curl of plums, not hitherto described, on the powdery mildew of grapes, and the shot-hole fungus of plums.

Attention has also been necessarily directed to certain dangerous insect pests.

Specimens of wood sent by an orchardist living near New London from trees which were dying or dead, proved to be affected with the dreaded San José scale. Dr. Sturgis and Mr. Britton immediately visited the orchards, directed the course of treatment to keep the disease in check, till a winter treatment could be used to eradicate it, and a Bulletin was at once issued to call the attention of fruit growers to the subject.

Certain other insect injuries to fruit and ornamental trees have also been studied.

Horticultural Work.

Mr. Britton, with the coöperation of Dr. Jenkins, has made a study of the relative availability of different forms of organic nitrogen by vegetation experiments with corn and oats. In addition to the artificial soil used in 1894, two other soils have been used for this work; one a soil on which corn has been raised for five years in succession without fertilizers, the other from a pasture which has been uncultivated for at least thirteen years and has had no fertilizer for the last six years. These vegetation experiments, 137 in number, have been made in galvanized pots and were carried out during the summer season in a house built specially for such purposes.

During the winter a study was begun, in the forcing house, of the fertilizer requirements of the tomato and lettuce crops, and of

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the growth of these crops with fertilizer chemicals in artificial soils.

Field Experiments.

Under the supervision of Dr. Jenkins, two field experiments have been made to study the effect on the quality, as well as the quantity, of the potato crop, of applications of various potash salts, both with and without lime.

An experiment on bringing worn-out sandy land into arable condition, by the use of chemical fertilizers and leguminous crops, has been begun.

The extensive experiment on the effect of fertilizers on the quality and quantity of the tobacco crop, and the experiment on the growth of maize continuously on the same land, previously noticed in our reports, have been continued this year.

The Grass Garden.

Mr. J. B. Olcott has continued the study of native and foreign turf-making grasses in the Grass Garden at South Manchester. The garden has been considerably enlarged during the year by collections made in England, France, Denmark and Austria by Mr. Olcott.

Station Publications.

The eighteenth report of this Station, for the year 1894, a volume of 296 pages, has been issued in an edition of 12,000 copies, and the 7,000 copies at the disposal of this Station have been distributed, after satisfying our exchanges, among the farmers of Connecticut. Less than 25 copies remain in our hands.

A spraying calendar for the use of Connecticut farmers was issued during March in an edition of 1,800 copies.

Bulletin No. 120, on Analyses of Fertilizers, Trade Values of Fertilizer Ingredients for 1895, and Poultry Foods, containing sixteen pages, was issued in April in an edition of 4,000 copies.

Bulletin 121, on The Elm Leaf Beetle; and the San José Scale; containing sixteen pages, was issued in July, in two editions of 7,000 copies.

These Bulletins are republished in the Annual Report of Station Work for the year.

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Attendance at Farm Institutes and other Farmers' Meetings.

In response to request, members of the Station staff have attended a considerable number of meetings of farmers during the year and read papers or made addresses. The time devoted to this work has been equivalent to twenty-four days' time of one man.

Correspondence.

During the year 1728 letters have been written by the Station staff and 885 manuscript reports of fertilizer and seed tests have been made.

New Buildings.

A forcing house, fifty feet long by twenty feet wide, with a potting room twenty-five feet by ten is now being built and will be used during the coming winter for further experiments on the fertilizer requirements of forcing-house crops.

Meetings of the Board.

During the year ending October 31, the Board of Control has held three meetings.

All of which is respectfully submitted.

WM. H. BREWER, *Secretary.*

Nov. 1st, 1895.

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REPORT OF STATION WORK.

A general statement regarding the work done by the Station Staff is to be found on previous pages in the Report of the Board of Control to the Governor.

The following papers present a full and detailed account of the operations of the Station within the twelve month ending October 31, 1895.

It has been found necessary to repeat annually certain statements regarding the fertilizer law and the explanations regarding the analysis and valuation of fertilizers.

FERTILIZERS.

More than 22,500 tons of Commercial Fertilizers are annually brought into Connecticut. This does not include the large quantities of cotton seed meal and cotton hull ashes used in the tobacco-growing sections, nor the unleached Canada ashes used generally throughout the State.

More than $700,000 are annually paid by Connecticut farmers for fertilizers.

In 1883, the year following the passage of the fertilizer law, 38 manufacturers entered 90 brands of fertilizers for sale in the State. The number of brands has increased steadily year by year, while the number of firms doing the fertilizer business has remained about the same.

During the season of 1895 the forty-seven manufacturing firms doing business in the State have entered two hundred and nine brands for sale. These include :

Special manures made for particular crops,	75	brands.
Other nitrogenous superphosphates,	89	"
Bone manures and bone and potash,	28	"
Chemicals, including tankage and castor pomace,	17	"
Total,	209	

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THE FERTILIZER LAW OF CONNECTICUT.

The General Assembly, at its session in 1882, passed an Act concerning Commercial Fertilizers which, as amended by an act passed at the session in 1893, is still in force. Copies of those sections of the General Statutes of Connecticut which relate to commercial fertilizers may be had on application to the Station.

Attention is specially called to the following requirements:

1. In case of *all* fertilizers or manures, except stable manure and the products of local manufactures of less value than ten dollars a ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER has provided labels or statements and has paid the fee. Sections 4005 and 4007.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, and which are generally Nitrogen, Phosphoric Acid and Potash. The analysis-fees in case of any fertilizer will therefore usually be ten, twenty or thirty dollars, according as one, two or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, *in the case of every commercial fertilizer*, that a *sealed sample* shall be deposited with the Director of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him. Section 4006.

A statement of the per cent. of Nitrogen, Phosphoric Acid (P_2O_5) and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc, the chemical composition may take account of the two ingredients: Nitrogen and Phosphoric Acid.

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For Potash Salts give always the per cent. of Potash (potassium oxide): that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price*, shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4008.

4. All "CHEMICALS" that are applied to land, such as Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Lime (Gypsum or Land Plaster), Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 4013 of the Act.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 4013, that all fertilizers be analyzed, and it requires the parties making or selling them to pay for these analyses in part: the State itself paying in part by maintaining the Experiment Station.

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OBSERVANCE OF THE FERTILIZER LAW.

Here follows an alphabetical list of the manufacturers who have paid analysis fees as required by the Fertilizer Law, and the names or brands of the fertilizers for which fees have been paid by them for the year ending May, 1895.

Firm.	*Brand of Fertilizer.*
Alderman, G. B., Suffield, Conn.	Special Potato Fertilizer.
Armour Packing Co., Kansas City, Mo.	Fruit, Vegetable and Tobacco Special.
Baker, H. J. & Bro., 93 William St., New York City.	Special Corn Manure. Special Tobacco Manure. Castor Pomace. A. A. Ammoniated Superphosphate. Complete Onion Manure. Complete Potato Manure. Harvest Home Phosphate.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Special Tobacco Manure. " " Grain Manure. " " Grass Top-Dressing and Forage Crop Manure. Stockbridge Special Potato and Vegetable Manure. Bowker's Hill and Drill Phosphate. " Farm and Garden Phosphate or Ammoniated Bone Fertilizer. " Potato Manure. " Tobacco Grower. " Sure Crop Bone Phosphate. " Market Garden Manure. " Bone and Potash, Square Brand.
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Bradley's Superphosphate. " Potato Manure. " Complete Manure for Potatoes and Vegetables. " Complete Manure for Top-Dressing Grass and Grain. " Complete Manure for Corn and Grain. " Pure Fine Ground Bone. " Ground Bone and Potash, Circle Brand. " Fish and Potash, Anchor Brand. " Fish and Potash, Triangle A Brand. " B. D. Sea Fowl Guano. " Original Coe's Superphosphate. " Farmer's New Method Fertilizer. " High Grade Tobacco Manure.

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Firm.	*Brand of Fertilizer.*
Buckingham, C., Southport, Conn.	A No. 1 Fertilizer.
Chicopee Guano Co., 140 Maiden Lane, New York City.	A 1 Vegetable and Potato Manure. Farmer's Reliable.
Church, Daniel T., Tiverton, R. I.	Fish and Potash.
Clark's Cove Fertilizer Co., Farlow Building, State St., Boston, Mass.	Bay State Fertilizer. Bay State Fertilizer G. G. Potato Manure. Great Planet. Potato and Tobacco Fertilizer. King Philip Guano. Fine Ground Bone.
Cleveland Dryer Co., 92 State St., Boston, Mass.	Cleveland Superphosphate. " Potato Phosphate.
Coe Co., The E. Frank, 133-137 Front St., New York City.	E. Frank Coe's High Grade Potato Fertilizer. E. Frank Coe's High Grade Phosphate. " " Alkaline Bone. " " Ground Bone and Potash.
Cooper's Glue Factory, Peter, 17 Burling Slip, New York City.	Bone Dust.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Crocker's Special Potato Manure. " Practical Ammoniated Superphosphate. " Ammoniated Wheat and Corn Superphosphate. " Vegetable Bone Superphosphate. " New Rival Ammoniated Superphosphate. " Pure Ground Bone. " Special Conn. Tobacco Manure. " Potato, Hop and Tobacco Phosphate. " Ammoniated Bone Superphosphate.
Cumberland Bone Phosphate Co., State St. and Merchants Row, Boston, Mass.	Cumberland Superphosphate. " Potato Fertilizer. " Fertilizer. " Concentrated Phosphate. " Ground Bone.
Darling Fertilizer Co., The L. B., Pawtucket, R. I.	Potato and Root Crop Manure. Animal Fertilizer. Garden and Lawn. Tobacco Grower. Fine Bone. Animal "G."
Downes & Griffin, Birmingham, Conn.	Ground Bone.

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Firm.	*Brand of Fertilizer.*
Eastern Farm Supply Association, Montclair, N. J.	Carteret Long Island Special. " Market Garden Manure. " Potato Manure.
Ellsworth, F., Hartford, Conn.	Shoemaker's Swift Sure Bone Meal. " " " Superphosphate. Collier Castor Pomace.
Great Eastern Fertilizer Co., Rutland, Vermont.	Great Eastern General for Grass and Grain. Great Eastern Vegetable, Vine and Tobacco. Great Eastern General. Soluble Bone and Potash.
Hartford Fertilizer Co., Hartford, Conn.	Bone Meal.
Kelsey, E. R., Branford, Conn.	Bone, Fish and Potash.
Lister's Agricultural Chemical Works, Newark, N. J.	Success Fertilizer. Potato Manure. Special Potato Fertilizer. Special Tobacco Manure. Animal Bone and Potash. Ammoniated Dissolved Bone Phosphate. Standard Pure Bone Superphosphate. Crescent Bone Dust.
Ludlam, Frederick, 108 Water St., New York City.	Cereal. Cecrops or Dragon's Tooth.
Lyman, Chas. E., Middlefield, Conn.	Corn Manure. Potato Manure.
Mapes' Formula and Peruvian Guano Co., 143 Liberty St., New York City.	Potato Manure. Complete Manure for General Use. Fruit and Vine Manure. Corn Manure. Fine Bone Dissolved. Complete Manure for Light Soils or Vegetable Manure. Tobacco Starter. Grass and Grain Spring Top-Dressing. Complete Manure "A" Brand. Tobacco Manure. Wrapper Brand. Seeding Down Manure.
Mason, Chapin & Co., Providence, R. I.	Odorless Chemical Compound. Odorless Chemical Compound for Tobacco. Odorless Chemical Compound for Lawn and Grass. Homestead Chemical Compound. Homestead Chemical Compound for Tobacco. Homestead Chemical Compound for Lawn and Grass.

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Firm.	*Brand of Fertilizer.*
Miles, G. W., Milford, Conn.	Ground Fish. IXL Ammoniated Bone Superphosphate.
Miller, Geo. W., Middlefield, Conn.	Unexcelled Phosphate. Ground Bone.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Complete Fertilizer. " Ammoniated Bone Phosphate. " Fish and Potash. " Ground Bone.
Niagara Fertilizer Works, Buffalo, N. Y.	Niagara Wheat and Corn Producer. " Triumph. " Grass and Grain Grower. " Potato, Tobacco and Hop Fertilizer.
Nuhn, Frederick, Waterbury, Conn.	Self-Recommending Fertilizer.
Olds & Whipple, Hartford, Conn.	O. & W. Special Phosphate. Red Seal Castor Pomace.
Pacific Guano Co., Boston, Mass.	Soluble Pacific Guano. Special Potato Manure. Special for Potatoes and Tobacco. Nobsque Guano. Fine Ground Bone. High Grade General Fertilizer. Pacific Fish and Potash.
Peck Bros., Northfield, Conn.	Pure Ground Bone.
Plumb & Winton, Bridgeport, Conn.	Ground Bone.
Preston Fertilizer Co., Greenpoint, R. I.	Potato Fertilizer. Ammoniated Bone Superphosphate.
Quinnipiac Co., 92 State St., Boston, Mass.	Quinnipiac Phosphate. " Potato Manure. " Market Garden Manure. " Grass Fertilizer. " Corn Manure. " Onion Manure. " Havana Tobacco Fertilizer. " Pure Bone Meal. " Dry Ground Fish. " Pine Island Phosphate. " Fish and Potash, Crossed Fishes Brand. Nitrate of Soda. Muriate of Potash. Double Manure Salts. Sulphate of Potash.
Read Fertilizer Co., Box 3121, New York City.	Read's Standard. High Grade Farmer's Friend. Fish and Potash. Vegetable and Vine.

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Firm.	*Brand of Fertilizer.*
Rogers & Hubbard Co., Middletown, Conn.	The Rogers & Hubbard Co's Pure Raw Knuckle Bone Flour. The Rogers & Hubbard Co's Pure Raw Knuckle Bone Meal. The Rogers & Hubbard Co's Strictly Pure Fine Bone. The Rogers & Hubbard Co's Oats and Top-Dressing Fertilizer. The Rogers & Hubbard Co's Soluble Potato Manure. The Rogers & Hubbard Co's Soluble Tobacco Manure. The Rogers & Hubbard Co's Grass and Grain Fertilizer. Fairchild's Corn Formula and General Crops.
Rogers Mfg. Co., Rockfall, Conn.	Pure Ground Bone. Grass and Grain Fertilizer. Soluble Potato and General Crops. High Grade Fertilizer for Oats and Top-Dressing. Complete Fertilizer. High Grade Corn Fertilizer.
Sanderson, L., New Haven, Conn.	Old Reliable Superphosphate. Formula A (Complete). Pulverized Bone and Meat. Blood, Bone and Meat. Fine Ground Bone. Muriate of Potash. High Grade Sulphate of Potash. Regular Sulphate of Potash. Nitrate of Soda. Sulphate of Ammonia. Dissolved Bone Black.
Standard Fertilizer Co., Farlow Building, State St., Boston, Mass.	Standard Superphosphate. " Fertilizer. " Potato and Tobacco Fertilizer. " Complete Manure. " Guano. " Ground Bone.
Walker, Stratman & Co., Pittsburgh, Pa.	Potato Special. Smoky City. Big Bonanza. Four Fold.
Wheeler, M. E. & Co., Rutland, Vermont.	High Grade Potato Manure. Electrical Dissolved Bone. Grass and Oats Fertilizer.
Wilcox, Leander, Mystic, Conn.	Potato, Onion and Tobacco Manure. Ammoniated Bone Phosphate. Complete Bone Superphosphate. High Grade Fish and Potash.

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Firm.	*Brand of Fertilizer.*
Wilkinson & Co., 54 William St., New York City.	Economical Bone Fertilizer.
Williams & Clark Fertilizer Co., 81 Fulton St., New York City.	Americus High Grade Special. " Ammoniated Bone Superphosphate. " Potato Phosphate. " Fine Wrapper Tobacco. " Corn Phosphate. " Potato and Tobacco Fertilizer. Dry Ground Fish Guano. Royal Bone Phosphate. Fish and Potash. Grass Manure. Pure Bone Meal.

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SAMPLING AND COLLECTION OF FERTILIZERS.

During April, May and June, Messrs. C. L. Backus of Andover and M. H. Parker of South Coventry, agents of this Station, visited one hundred and six towns and villages of Connecticut to draw samples of Commercial Fertilizers for analysis. These places were distributed as follows:

Litchfield County,	5
Hartford "	27
Tolland "	8
Windham "	11
New London "	9
Middlesex "	14
New Haven "	16
Fairfield "	16
	106

In these places the agents drew 555 samples, representing 199 brands of fertilizers.

In this way one or more samples were secured of nearly every brand of fertilizer which is offered for sale within the State. When several samples of a single brand were drawn in different parts of the State the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agents are instructed in every case to open at least three packages of each brand for sampling, and if the number of packages is large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

As a rule, the Station will not analyze samples—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

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The Station desires the coöperation of farmers, farmers' clubs and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. All samples drawn by other than Station agents *must be drawn in strict accordance with the Station's Instructions for Sampling, and must also be properly certified*, if the Station analysis is desired. A copy of these instructions and blank certificates will be sent on application.

ANALYSIS OF FERTILIZERS.

During the year, 416 samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given on page 18.

On a few of these samples analyses were made for private parties and charged for accordingly. A few samples also were analyzed at request of other Experiment Stations in order to compare and test analytical methods. Results of the examination of all the samples, with these exceptions, are given in detail in the following pages.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for explanation or protest, before the results are published.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

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EXPLANATIONS CONCERNING THE ANALYSIS OF FERTILIZERS AND THE VALUATION OF THEIR ACTIVE INGREDIENTS.*

The Elements of Fertilizers.

The three chemical elements whose compounds chiefly give value, both commercial and agricultural, to fertilizers are Nitrogen, Phosphorus and Potassium. The other elements found in fertilizers, viz: Sodium, Calcium, Magnesium, Iron, Silicon, Sulphur, Chlorine, Carbon, Hydrogen and Oxygen, which are necessary or advantageous to the growth of vegetation, are either so abundant in the soil or may be so cheaply supplied to crops, that they do not considerably affect either the value or cost of high-priced commercial fertilizers.

Nitrogen in fertilizers is, on the whole, the least abundant of their valuable elements and is, therefore, their most costly ingredient.

Free Nitrogen is universally abundant, making up nearly four-fifths of the common air, and appears to be assimilable, with aid of certain bacteria, by leguminous plants (the clovers, alfalfa, peas, beans, lentils, esparsette, lupins, vetches, lathyrus, peanut, yellow locust, honey locust, etc.), and by a few non-leguminous plants, carrying root-nodules, viz: the Oleasters (*Eleagnus*), the Alders (*Alnus*), and a single family of coniferous trees (*Podacarpus*), but not at all, according to present evidence, by the cereals or other field and garden crops.

Organic Nitrogen is the nitrogen of animal and vegetable matters which is chemically united to carbon, hydrogen and oxygen. Some forms of organic nitrogen, as those of blood, flesh and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated. Since organic nitrogen may readily take the form of ammonia, it has been termed *potential ammonia*.

Ammonia (NH_3) *and Nitric Acid* (N_2O_5) are results of the decay of *organic nitrogen* in the soil and manure heap, and contain nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda: 17 parts of ammonia or 66 parts of pure sulphate of ammonia contain 14 parts of nitrogen; 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

Phosphorus is, next to nitrogen, the most costly ingredient of fertilizers, in which it exists in the form of phosphates, usually those of calcium, iron and aluminum, or in case of "superphosphates," to some extent in the form of free phosphoric acid.

Water-Soluble Phosphoric Acid is phosphoric acid (or a phosphate) that freely dissolves in water. It is the characteristic ingredient of superphosphates, in which it is produced by acting on "insoluble" (or

* Prepared and revised by the Director.

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"citrate soluble") phosphates, with diluted sulphuric acid. Once well incorporated with the soil, it gradually "reverts" and becomes insoluble, or very slightly soluble, in water.

Citrate-soluble Phosphoric Acid signifies the phosphoric acid (of various phosphates) that is freely taken up by a hot strong solution of neutral ammonium citrate, which solution is therefore used in analysis to determine its quantity. The designation *citrate-soluble* is synonymous with the less explicit terms *reverted*, *reduced* and *precipitated*, which all imply phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid.

Recent investigation tends to show that water-soluble and citrate-soluble phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the water-soluble gives better results on crops, in others the "reverted" is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric Acid implies various phosphates insoluble both in water and in hot solution of neutral ammonium citrate. The phosphoric acid of Canadian "Apatite," of South Carolina and Florida "Rock Phosphate" and of similar dense mineral phosphates, as well as that of "bone-ash" and "bone-black," is mostly insoluble in this sense, and in the majority of cases gives no visible good results when these substances, in the usual ground state, are applied to crops. They contain, however, a small proportion of citrate-soluble phosphoric acid, and sometimes, when they are reduced to extremely fine dust (floats) or applied in large quantities, especially on "sour soils" or in conjunction with abundance of decaying vegetable matter (humus), they operate as efficient fertilizers.

Available Phosphoric Acid is an expression properly employed in general to signify phosphoric acid in any form, or phosphates of any kind that serve to nourish vegetation. In the soil phosphoric acid and all phosphates, whatever their solubilities as defined in the foregoing paragraphs, are more or less freely and extensively available to growing plants. Great abundance of "insoluble" phosphoric acid may serve crops equally well with great solubility of a small supply, especially when the soil and the crop carry with them conditions highly favorable to the assimilation of plant food.

In Commercial Fertilizers, "available phosphoric acid" is frequently understood to be the sum total of the "water-soluble" and the "citrate-soluble," with exclusion of the "insoluble."

The "insoluble phosphoric acid" in a commercial fertilizer costing $20 to $50 per ton has very little or no value to the purchaser, because the quantity of it which can commonly go upon an acre of land has no perceptible effect on the crop, and because its presence in the fertilizer excludes an equal percentage of more needful and much more valuable ingredients.

In Raw Bone the phosphoric acid (calcium phosphate) is nearly insoluble, because of the animal matter of the bones which envelops it;

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but when the animal matter decays in the soil, or when it is disintegrated by boiling or steaming, the phosphate mostly remains in an available form. The phosphoric acid of "Basic-Slag" and of "Grand Cayman's Phosphate" is in some soils as freely taken up by crops as water-soluble phosphoric acid, but in other soils is much less available than the latter.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5), also termed among chemists phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of fertilizers which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride). In unleached wood-ashes it exists mainly as potassium carbonate.

VALUATION OF FERTILIZERS.

The valuation of a fertilizer, as practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend for their trade-value exclusively on the substances *nitrogen*, *phosphoric acid* and *potash*, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above named ingredients* a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

TRADE-VALUE OF FERTILIZER ELEMENTS, FOR 1895.*

The average Trade-values or retail costs in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash in raw materials and chemicals, as found in New England, New York and New Jersey markets during 1894, were as follows :

* Adopted at a conference of representatives of the Connecticut, Massachusetts, New Jersey and Rhode Island Stations held in March, 1895.

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	Cts. per lb.
Nitrogen in ammonia salts	18½
nitrates	15
Organic nitrogen in dry and fine ground fish, meat and blood and in mixed fertilizers	16½
in cotton seed meal	12
in fine bone and tankage	16
in fine-medium bone and tankage	14
in medium bone and tankage	11
in coarser bone and tankage	5
Phosphoric acid, water-soluble	6
citrate-soluble*	5½
of dry ground fine fish, bone and tankage	5½
of fine-medium bone and tankage	4½
of medium bone and tankage	3
of coarse bone and tankage	2
of fine ground fish, cotton seed meal, castor pomace and wood ashes	5
of mixed fertilizers insoluble in ammonium citrate	2
Potash as high-grade sulphate and in forms free from muriate (or chlorides)	5½
as muriate	4½

The foregoing are, as nearly as can be estimated, the prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those *raw materials* which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as:

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried Blood,	Plain Superphosphates,
Azotin,	Dry Ground Fish,
Ammonite,	Bones and Tankage,

Ground South Carolina Rock.

*Dissolved from 2 grams of the fertilizer, previously extracted with pure water, by 100 c.c. neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

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but when the animal matter decays in the soil, or when it is disintegrated by boiling or steaming, the phosphate mostly remains in an available form. The phosphoric acid of "Basic-Slag" and of "Grand Cayman's Phosphate" is in some soils as freely taken up by crops as water-soluble phosphoric acid, but in other soils is much less available than the latter.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5), also termed among chemists phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of fertilizers which ranks third in costliness. In plants, soils and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride). In unleached wood-ashes it exists mainly as potassium carbonate.

VALUATION OF FERTILIZERS.

The valuation of a fertilizer, as practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates and similar articles, for which $30 to $50 per ton are paid, depend for their trade-value exclusively on the substances *nitrogen, phosphoric acid* and *potash*, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above named ingredients* a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

TRADE-VALUE OF FERTILIZER ELEMENTS, FOR 1895.*

The average Trade-values or retail costs in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid and potash in raw materials and chemicals, as found in New England, New York and New Jersey markets during 1894, were as follows:

* Adopted at a conference of representatives of the Connecticut, Massachusetts, New Jersey and Rhode Island Stations held in March, 1895.

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	Cts. per lb.
Nitrogen in ammonia salts	18½
nitrates	15
Organic nitrogen in dry and fine ground fish, meat and blood and in mixed fertilizers	16½
in cotton seed meal	12
in fine bone and tankage	16
in fine-medium bone and tankage	14
in medium bone and tankage	11
in coarser bone and tankage	5
Phosphoric acid, water-soluble	6
citrate-soluble*	5½
of dry ground fine fish, bone and tankage	5½
of fine-medium bone and tankage	4½
of medium bone and tankage	3
of coarse bone and tankage	2
of fine ground fish, cotton seed meal, castor pomace and wood ashes	5
of mixed fertilizers insoluble in ammonium citrate	2
Potash as high-grade sulphate and in forms free from muriate (or chlorides)	5½
as muriate	4½

The foregoing are, as nearly as can be estimated, the prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those *raw materials* which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices* at the large markets of standard raw materials, such as:

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried Blood,	Plain Superphosphates,
Azotin,	Dry Ground Fish,
Ammonite,	Bones and Tankage,

Ground South Carolina Rock.

*Dissolved from 2 grams of the fertilizer, previously extracted with pure water, by 100 c.c. neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

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Valuation of Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The Organic Nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality, 18½ cents.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at 4½ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 5½ cents per pound.

In most cases the valuation of the ingredients in superphosphates and specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. The charges are for grinding and mixing, bagging or barreling, storage and transportation, commission to agents and dealers, long credits, interest on investments, bad debts and, finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling and cartage ranges from $3.00 to $4.50 per ton.

In 1895 the average selling price of Ammoniated Superphosphate and Guanos was $32.32 per ton, the average valuation was $23.37 and the difference $8.95, an advance of 38.2 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

In case of Special manures the average cost was $37.33, the average valuation $27.94 and the difference $9.39 or 33.6 per cent. advance on the valuation.

To obtain the Valuation of a Fertilizer we multiply the pounds per ton of nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per ton.

In case of *Ground Bone*, the sample is sifted into four grades and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton by the per cent. of each grade, taking $\frac{1}{100}$th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

Uses and Limitations of Fertilizer Valuation.

The uses of the "Valuation" are two-fold:

1. To show whether a given lot or brand of fertilizers is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

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2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for in some cases analysis cannot discriminate positively between the active and the inert forms of nitrogen, while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second named use of valuation frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth, when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of the year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

Agricultural Value of Fertilizers.

The Agricultural Value of a fertilizer is measured by the benefits received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that ground bone superphosphates, fish-scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

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CLASSIFICATION OF FERTILIZERS ANALYZED.

RAW MATERIALS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

Nitrate of Soda	9
Dried Blood	1
Horn and Hoof	1
Leather	5
Cotton Seed Meal	30
Castor Pomace	7

2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*

Rock Phosphate	2
Odorless Mineral Guano	1
Dissolved Bone Black	4
Dissolved Rock Phosphate	11

3. *Containing Potash as the Chief Valuable Ingredient.*

High Grade Sulphate of Potash	2
Double Sulphate of Potash and Magnesia	3
Muriate of Potash	7
Saltpeter Waste	2

4. *Containing Nitrogen and Phosphoric Acid.*

Bone Manures	34
Tankage	11
Fish	8

MIXED FERTILIZERS.

Bone and Potash	8
Nitrogenous Superphosphates and Guanos	106
Special Manures	101

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes	23
Wood Ashes	17
Home Mixtures	15
Muck	4
Marine Mud	2
Beef Scraps	1
Anthracite Ashes	1
Total	416

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DESCRIPTION AND ANALYSES OF FERTILIZERS.*

I. Raw Materials Chiefly Valuable for Nitrogen.

Nitrate of Soda or Sodium Nitrate.

Nitrate of Soda is mined in Chili and purified there before shipment. It contains about 16 per cent. of nitrogen, equivalent to 97 per cent. of pure sodium nitrate. The usual guarantee is "96 per cent." of sodium nitrate, equivalent to 15.8 per cent. of nitrogen.

4511. Sold by National Fertilizer Co., of Bridgeport, to S. E. Curtis, Stratford, and sampled by him.

4489. Sold by National Fertilizer Co., to T. J. Stroud, Shaker Station, and sampled by him.

4777. Sold for Quinnipiac Co. Boston. Stock of Olds & Whipple, Hartford.

4926. Stock of Olds & Whipple, Hartford. Sampled and sent by P. P. Hickey, Burnside.

4762. Sold by Read Co., of New York, to A. Wetmore, Litchfield, and sampled by Milo D. Beach, Litchfield.

4778. Sold by L. Sanderson, New Haven.

4629. Bought of New York broker by J. Norris Barnes, Yalesville, and sampled by him.

Analyses.

	4511	4489	4777	4926	4762	4778	4629
Moisture	.21	.94	2.10	4.25	1.26	1.77	2.05
Insoluble in water	.17	.20	.30	2.37	.21	.40	.00
Common Salt	.13	.20	.98	.79	.45	.99	.86
Sodium Sulphate	.27	.23	.37	2.12	.12	.27	.33
Sodium Nitrate	99.22	98.43	96.25	90.47	97.96	96.57	96.76
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Equivalent Nitrogen	16.37	16.24	15.88	14.92	16.15	15.93	15.95
Cost per ton	$50.00§	50.00	50.00	55.00	48.20†	50.00	39.60‡
Nitrogen costs cents per pound	15.2	15.4	15.7	18.4	14.9	15.7	12.5

* This chapter, pages 19 to 74, has been prepared for publication by Dr. Jenkins. The analyses of fertilizers have been made by Messrs. Winton and Ogden with the constant assistance of Mr. Lange.

† Wholesale, at Litchfield. ‡ In car lot at Yalesville.

§ The prices given are regular retail rates unless otherwise stated.

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Sample **4926** is of inferior quality. It contains several per cent. more of moisture, sand and other impurities than the other samples, and correspondingly less nitrogen.

The samples **4511** and **4489** were drier than the average, and in consequence the per cent. of nitrogen was higher. The others are of average quality, and the average retail price for the season has been about 15½ cents per pound of nitrogen.

Dried Blood.

This consists of slaughter-house blood which has been dried by superheated steam or hot air. It is a finely pulverized, nearly odorless substance, red or dark red in color, and rich in nitrogen that is quickly available to vegetation.

4544. Purchased of L. Sanderson, New Haven, for vegetation experiments. The material contained 13.40 per cent. of nitrogen and 1.54 of phosphoric acid and cost $40.00 per ton, making the cost of nitrogen 14.4 cents per pound.

Preparations of Leather.

As has been proved abundantly by experiment, leather, whether in its untreated state or steamed or roasted, and pulverized, has no value as a fertilizer. The State fertilizer law wisely forbids its use in any form as an ingredient of commercial fertilizers without explicit printed certificate of the fact, "such certificate to be conspicuously affixed to every package," etc.

The materials on which the following analyses were made were used in vegetation experiments to be described on following pages.

4565. Ground leather, imported from England, for use as a cheap "ammoniate" in mixed fertilizers. The method of manufacture is unknown. It is a brownish black powder, in appearance resembling dried blood. When pulverized it emits an odor of benzine.

4581. Hemlock-tanned sole leather.

4622. Steamed leather prepared from **4581** by heating over water in the autoclave for 1¾ hours at a pressure of 58 pounds to the square inch, and drying the gummy product in the water-bath.

4623. Roasted leather prepared from **4581** by heating the powdered leather at 240° C. for four hours.

4625. Dissolved leather. 148 grams of samples **4581** and 100 grams of oil of vitriol, sp. gr. 1.84, were heated gradually, with

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constant stirring, till fumes of sulphurous acid appeared. Water was added and the mass digested, evaporated to dryness, and heated till sulphurous acid was evolved. Water was again added, the acid was nearly neutralized with carbonate of lime, and the whole dried on the water-bath.

ANALYSES.

	From England.	Sole Leather.	Steamed Leather.	Roasted Leather.	Dissolved Leather.
	4565	4581	4622	4623	4625
Nitrogen.....	7.39	6.76	6.21	8.54	2.81

COTTON SEED MEAL.

This material is of two kinds, which are known in trade respectively as undecorticated and decorticated. In their manufacture cotton seed is first ginned to remove most of the fiber, then passed through a "linter" to take off the short fiber or lint remaining, then through machines which break and separate the hulls. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer. In case of undecorticated meal the hulls and the ground press-cake are mixed together.

Nitrogen alone has been determined in most of the samples whose analyses follow. In those cases the per cents. of phosphoric acid and potash given in the table are the averages derived from all the analyses of decorticated meal made in the last two years at this Station. The per cent. amounts of phosphoric acid and potash in clear cotton seed meal do not vary so much in different samples as to make their determination necessary in order to determine the general quality of the sample.

Two of the samples, **4604** and **4466**, consist of undecorticated meal, containing only about four per cent. of nitrogen. The purchase of this low grade meal, at present prices, is not economical.

The average cost of nitrogen per pound in the twenty-five samples was 11.2 cents; the lowest price paid was 8.6 cents, the highest 13.5.

Cotton seed meal has been by far the cheapest source of available nitrogen, during the past season. Experiments indicate that it is as rapidly and fully available as the best forms of animal matter. It has been extensively used this year in home-mixed fertilizers and has given perfect satisfaction.

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Analyses of Cotton Seed Meal.

Station No.	Dealer.	Sampled by	Nitrogen.	Phosphoric Acid.	Potash.	Cost per Ton.	Nitrogen costs cents per pound.
4508	Not stated	Station agent, from stock of S. D. Woodruff & Sons, Orange.	8.32	2.42	1.69	$18.50	8.6
4767	Noble Bennett, New Milford	Noble Bennett, New Milford	6.81	2.81	1.85	18.00	9.7
4665	Abner Hendee, New Haven	Station agent, stock of J. H. Webb, Hamden	7.16	2.81	1.85	18.75	9.8
4810	Olds & Whipple, Hartford	C. J. Dewey, stock of Wilbur Hills, Buckland	6.97	2.81	1.85	18.50	9.8
4708	James Perkins, Suffield	F. B. Hathaway, Suffield	6.98	2.81	1.85	18.50	9.8
4550	C. M. Cox & Co., Boston, Mass.	C. J. Dewey, Buckland	7.20	2.81	1.85	19.00	9.9
4765	B. C. Patterson, Torrington	Milo D. Beach, Litchfield	8.08	2.81	1.85	21.00	10.0
4811	August Pouleur, Windsor	L. L. Bedortha, Windsor	6.93	2.81	1.85	19.00	10.2
4498	Abner Hendee, New Haven	Station agent, stock J. H. Webb, Hamden	7.76	2.81	1.85	21.00	10.4
4707	W. S. Pinney, Suffield	S. Seymour, Windsor Locks	6.80	2.81	1.85	19.00	10.5
4569	F. L. Worthy & Co., Mittineague, Mass	David L. Brockett, Suffield	7.70	2.81	1.85	21.25	10.7
4503	H. K. Brainard, Thompsonville	E. N. Barnes, Thompsonville	7.08	2.81	1.85	20.50	11.1
4735	Abner Hendee, New Haven	H. C. C. Miles, Milford	7.00	2.81	1.85	21.00	11.6
4509	Not stated	S. E. Curtis, Stratford	6.96	2.81	1.85	21.00	11.7
4589	Olds & Whipple, Hartford	T. W. Lester, Windsor Locks	7.12	2.81	1.85	21.50	11.7
4583	Olds & Whipple, Hartford	Wm. S. Pinney, Suffield	6.38	2.81	1.85	19.00	12.0
4709	Olds & Whipple, Hartford	P. P. Hickey, Burnside	6.96	2.81	1.85	21.50	12.0
4570	F. L. Worthy & Co. Mittineague, Mass.	David L. Brockett, Suffield	6.55	2.81	1.85	20.00	12.0
4481	A. E. Arnold	Wm. W. Thompson, Warehouse Point	7.90	2.06	1.73	23.00	12.1
4495	R. A. Parker, Warehouse Point	Wm. W. Thompson, Warehouse Point	7.28	2.81	1.85	22.50	12.2
4522	Olds & Whipple, Hartford	H. V. Griffin, East Granby	6.96	2.81	1.85	22.00	12.4
4497	Not stated	S. E. Curtis, Stratford	6.56	2.81	1.85	21.00	12.4
4480	J. M. Williams, Manchester	W. H. Olcott, So. Manchester	6.87	3.15	2.01	23.00	12.9
4502	Olds & Whipple, Hartford	G. S. Phelps, Warehouse Point	6.79	2.81	1.85	23.00	13.4
4675	For Tobacco Experiment	Station agent	6.65	2.35	1.73	22.00	13.5
4604	N. C. Hall & Co., New Haven	James H. Webb, Hamden	4.0	....	....	15.00	....
4560	F. A. Betts, New Haven		8.40	....	....	....	....
4466	Not stated	F. Ellsworth, Hartford	4.10	....	....	....	....
4494	Not stated	S. O. Griswold, Windsor	7.21	....	....	....	....
4591	Not stated	Miss M. A. Neale, Southington	8.59	....	....	....	....

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Castor Pomace.

This is the ground residue of castor beans from which castor oil has been extracted. It is an excellent fertilizer, but extremely poisonous to animals, which often eat it greedily when the opportunity offers.

4893. Made by H. J. Baker & Bro., N. Y. From stock of Edmund Halliday, Suffield.

4738. Made by H. J. Baker & Bro. Sampled and sent by Francis Granger, East Granby.

4895. Made by Collier Co., St. Louis, Mo. Stock of F. Ellsworth, Hartford.

4545. Made by Collier Co. Stock of F. Ellsworth. Stock of 1894.

4894. Made by Red Seal Castor Oil Co., St. Louis, Mo. From stock of Olds & Whipple, Hartford.

4546. Made by Red Seal Castor Oil Co. From stock of Olds & Whipple. Stock of 1894.

4676. Bought of Bowker Fertilizer Co., Boston, for the Tobacco Experiment Co.

Analyses.

	4893	4738	4895	4545	4894	4546	4676
Nitrogen	4.56	4.42	5.50	4.78	4.78	4.98	5.04
Phosphoric Acid	1.71	----	1.69	----	1.87	----	4.18
Potash	1.16	----	.93	----	.93	----	1.81
Cost per Ton	$18.50		19.00		20.00		15.00
Nitrogen costs cents per pound	17		14.7		17.9		8.8

The per cents. of phosphoric acid and potash in sample **4676** are abnormally large for this material.

Castor Pomace is an expensive form of organic nitrogen at present prices and is used chiefly by certain tobacco growers who still prefer it to cotton seed meal. The Poquonock experiments indicate that cotton seed meal in equivalent quantity yields tobacco of the same quality in all respects as castor pomace, and at a much lower cost for fertilizers.

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II. Raw Materials of High Grade Containing Phosphoric Acid as the Chief Valuable Ingredient.

Odorless Mineral Guano.

4499. This material, sold by the Forest City Ash Co., Boston, Mass., sampled and sent by T. J. Stroud, Shaker Station, is stated by the agents to be a Florida Soft Phosphate.

It contained 20.52 per cent. of phosphoric acid, of which 18.73 per cent. was insoluble in water and ammonium citrate.

Dissolved Bone Black and Dissolved Rock Phosphate.

Dissolved Bone Black.

Bone Black, made by subjecting bone to a red heat without access of air, is used in sugar refineries to decolorize sugar solutions. The waste bone black dried, and treated with oil of vitriol, makes a "superphosphate" of high grade which does not cake together on standing, but remains as a fine powder suitable for application to the land.

4780. Stock of L. Sanderson, New Haven.

4638. Stock of Leander Wilcox, sampled and sent by Lawrence Daily, East Windsor Hill.

4661. Sold by Mapes' F. & P. G. Co. in 1894.

4662. Sold by L. Sanderson in 1893. The two last were sent by Prof. C. J. Phelps, of the Storrs Agricultural College.

See table of analyses, page 26.

Dissolved Rock Phosphate or Acid Rock.

This material, made by treating various mineral phosphates with oil of vitriol, is the most common source of the phosphoric acid of factory-mixed fertilizers.

The per cent. of phosphoric acid in a fertilizer multiplied by 2.18 gives the amount of tricalcium phosphate or so-called "bone phosphate," which figures in commercial transactions but does not signify that the phosphate is derived from bone.

4507. Made by Liebig Manufacturing Co., Cartaret, N. J. From stock bought by S. D. Woodruff & Sons, Orange.

4493. Made by Liebig M'f'g Co. Sample sent by manufacturer.

4513. Sold by National Fertilizer Co., Bridgeport. Sampled and sent by S. E. Curtis, Stratford.

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4490. Sold by National Fertilizer Co. Sampled and sent by T. J. Stroud, Shaker Station.

4764. Read's Dissolved Bone. Made by Read Fertilizer Co., N. Y. Stock of A. Wetmore, Litchfield. Sampled and sent by Milo D. Beach, Litchfield.

4664. Sold by L. Sanderson, New Haven, from stock bought by J. H. Webb, Hamden.

4736. Sold by G. F. Taylor and Brush, New York City. Sampled and sent by H. C. C. Miles, Milford.

4628. Bought from New York broker. Sampled and sent by J. Norris Barnes, Yalesville.

4875. Electrical Dissolved Bone. Made by M. E. Wheeler & Co., Rutland, Vt. Sampled from stock of P. B. Moffit, Pomfret, and Wm. M. Owen, North Haven.

See table of analyses, page 26.

In acid rock phosphate available phosphoric acid has cost on the average very considerably less than in dissolved bone black. Those who have tried the acid phosphate in home-mixed fertilizers report very favorably, finding little or no trouble from caking or "setting" after mixing. There is no reason in the claim that the "available" phosphoric acid of the dissolved rock phosphates is any less valuable agriculturally than that of dissolved bone black. See further remarks on this subject, on pages 64 and 65.

III. Raw Materials of High Grade containing Potash.

High Grade Sulphate of Potash.

This chemical should contain over 90 per cent. of pure potassium sulphate (sulphate of potash) or about fifty per cent. of potassium oxide, the same quantity as is supplied by muriate, and should be nearly free from chlorine.

4728. Sold by the Quinnipiac Co. Sampled from stock of Olds & Whipple, Hartford.

4670. Sold by L. Sanderson, New Haven. Sampled from stock bought by Conn. Tobacco Experiment Co.

(For analyses see table on page 28.)

Double Sulphate of Potash and Magnesia.

This material is usually sold as "sulphate of potash" or "manure salt," on a guarantee of "48–50 per cent. sulphate," which is equivalent to 25.9–27.0 per cent. of potassium oxide. Besides

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Analyses.

	4780	4628	4661	4662	4507	4493	4513	4490	4764	4664	4736	4628	4875
Soluble phosphoric acid	16.29	16.67	16.11	16.46	8.58	13.00	8.35	12.83	5.74	11.31	12.34	9.86	7.65
Reverted phosphoric acid	.32	none.	.37	1.08	6.34	2.92	6.85	2.93	7.02	2.78	2.67	5.92	6.35
Insoluble phosphoric acid	.06	none.	.06	.18	1.47	.15	2.01	1.15	1.43	.40	1.11	.60	.53
Cost per ton	$26.00	26.00	----	----	11.50*	----	15.00	18.00	16.20‡	----	13.00	10.20†	24.00
"Available" phosphoric acid costs per pound	7.8	7.8	----	----	3.9	----	4.9	5.7	6.1	----	4.1	3.3	8.6

* Car lot in Orange. † Car lot in Yalesville. ‡ Wholesale in Litchfield.

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some 46–50 per cent. of potassium sulphate, it contains over 30 per cent. of magnesium sulphate, chlorine equivalent to 3 per cent. of common salt, a little sodium and calcium sulphates, with varying quantities of moisture.

4727. Sold by Quinnipiac Co., Boston. Sampled from stock of Olds & Whipple, Hartford.

4779. Sold by L. Sanderson, New Haven. Sampled from stock of Clifton Peck, Lebanon.

4672. Sold by L. Sanderson. Sampled from stock bought by the Conn. Tobacco Experiment Co.

(For analyses see table on next page.)

Muriate of Potash.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water.

It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of potassium oxide.

4701. Sold by Cumberland Bone Phosphate Co., Boston. Sampled and sent by D. C. Spencer, Saybrook.

4512. Sold by National Fertilizer Co., Bridgeport. Sampled and sent by S. E. Curtis, Stratford.

4892. Sold by Quinnipiac Co., Boston. Sampled from stock of O. S. Olmstead, Melrose.

4763. Sold by Read Fertilizer Co., N. Y. Sampled and sent by Milo D. Beach, Litchfield.

4666. Sold by L. Sanderson, New Haven. Sampled from stock bought by J. H. Webb, Hamden.

4506. Sampled from stock bought of a N. Y. broker by S. D. Woodruff & Sons, Orange.

4630. Sampled from stock bought of a N. Y. broker by J. Norris Barnes, Yalesville.

The analyses show the usual variations in composition. The Quinnipiac Co. has protested that analysis No. **4892** does not fairly represent the quality of the muriate sold by them, which contains a larger per cent. of potash than is shown by that analysis. The Station was unable to find other samples in market on which to make further analyses.

Potash in the sulphates, both high and low grade, has cost about one cent more per pound than in the muriates.

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Analyses of Potash Salts.

	High grade Sulphates.		Double Sulphates.			Muriates.						
	4728	4670	4727	4779	4672	4701	4512	4892	4763	4666	4506	4630
Actual Potash	47.36	50.39	26.95	28.12	28.39	49.78	50.73	50.07	50.60	50.30	49.77	51.03
Equivalent Sulphate	87.6	93.2	49.9	52.0	52.5	----	----	----	----	----	----	----
Equivalent Muriate	----	----	----	----	----	78.6	80.1	79.0	79.9	79.5	78.6	80.6
Cost per ton	$55.00	50.00	32.00	30.00	30.00	45.00	41.00	45.00	46.20	42.50	41.60†	40.60*
Actual potash costs cents per pound	5.8	4.9	5.9	5.3	5.3	4.5	4.0	4.4	4.5	4.2	4.2	3.8

* Car lot in Yalesville.

† Car lot.

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Saltpeter Waste.

Two samples of this material, **4542** light-colored, and **4543** dark colored, both from stock of Taylor & Brush, New York City, were sent for analysis by A. E. Plant, Branford.

Analyses.

	4542.	4543.
Nitrogen as nitrate.....	Trace.	.16
Potash.....	3.80	3.52

The material is for the most part salt. The amount of potash in a ton of it can be bought in form of muriate for about $3.00.

IV. Raw Materials containing Nitrogen and Phosphoric Acid.

Bone Manures.

The terms "Bone Dust," "Ground Bone," Bone Meal" and "Bone" applied to fertilizers, sometimes signify material made from dry, clean and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease and—if taken from garbage or ash heaps—with ashes or soil adhering; again they denote mixtures of bone, blood, meat and other slaughter-house refuse which have been cooked in steam-tanks to recover grease, and are then dried and sometimes sold as "tankage;" or, finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. The nitrogen of all these varieties of bone when they are in the same state of mechanical subdivision has essentially the same fertilizing value.

The method adopted for the valuation of bone manures, which takes account of their mechanical condition as well as chemical composition, is fully explained on page 16.

1. *Sampled by Station Agents.*

On pages 31 and 32 are tabulated twenty-five analyses of this class of bone manures.

In case a brand has sold at two or more different prices, the manufacturer's price, when known, has been used in calculating percentage difference.

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Otherwise an average, or nearly average price forms the basis of comparison between cost and valuation. The price thus employed is printed in heavy-faced type.

The Hartford Fertilizer Co. protested that analysis No. **4890** did not fairly represent their goods and was made on goods manufactured in the previous season. Another sample of the same brand, No. **4924**, was accordingly drawn and analyzed. It proved to be quite similar to the other in chemical composition, but was mechanically much finer.

The Rogers & Hubbard Co. protested that analysis No. **4773** of their Strictly Pure Fine Bone did not fairly represent its mechanical condition, and that the same brand for the last six years had shown a much finer state of pulverization. Accordingly another sample of the same brand, No. **4923**, was drawn and analyzed. It proved to be considerably finer than the sample previously examined and agreed with the average of the analyses of the last six years.

Sample **4882** was sent as Nuhn's Self-Recommending Fertilizer. This brand, however, is understood to contain potash.

Cost and Valuation.

The average cost per ton of the twenty-four brands of bone manures analyzed has been $32.09, and the average valuation $31.03 per ton.

2. *Sampled by manufacturers; and* 3. *Sampled by consumers.*

Sample **4889**, deposited at the Station by the manufacturer in compliance with the law, was analyzed to meet the requirement of the law which calls for an annual analysis of each brand. The sampling agents of the Station did not succeed in finding this brand on sale in the State.

The other samples described below were sent in by private parties and this Station is not responsible for the accuracy of the sampling. The Station holds, however, in each case a written certificate that the sample was drawn in accordance with its printed instructions.

2. *Sampled by Manufacturers.*

4889. Crescent Bone Dust. Made by Lister's Agricultural Chemical Works, Newark, N. J.

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Bone Manures Sampled by Station Agent.

Station No.	Name or Brand.	Manufacturer.	Dealer	Dealer's Cash Price per Ton.	Valuation per Ton.	Percentage Dif. between Cost and Valuation.	Chemical Analysis.		Mechanical Analysis.			
							Nitrogen.	Phos. Acid.	Finer than			Coarser than ¼ inch.
									1/10 inch.	⅛ inch.	¼ inch.	
						Valuation exceeds cost.						
4899	Bone Meal.	Danbury Fertilizer Co., Danbury.	E. Baker, Green's Farms.	$27.00	$36.72	26.4	3.96	24.14	70	24	6	--
			Manufacturer.	30.00	----	----	----	----	--	--	--	--
4924	Bone Meal.	Hartford Fertilizer Co., Hartford.	Manufacturer.	25.00	32.56†	23.2	2.45	25.73	71	15	7	7
4898	Chittenden's Ground Bone.	National Fertilizer Co., Bridgeport.	H. M. Ives, West Cheshire.	30.00	36.38	17.5	3.08	26.55	70	20	10	--
4711	Peter Cooper's Bone.	Peter Cooper's Glue Factory, New York City.	George Beaumont, Wallingford.	28.00	29.93	6.4	2.22	27.68	52	15	16	17
4669	Peter Cooper's Bone.	Peter Cooper's Glue Factory, New York City.	George Beaumont, Wallingford *	28.00	----	----	2.24	26.65	--	--	--	--
4613	Bone Meal.	Quinnipiac Co., Boston, Mass.	F. M. Raymond, Westport.	30.00	31.70	5.4	3.38	22.94	55	26	19	--
4775	Fine Ground Bone.	L. Sanderson, New Haven.	Clifton Peck, Lebanon.	33.00	34.48	4.2	4.16	24.64	44	33	23	--
4890	Bone Meal.	Hartford Fertilizer Co., Hartford.	Manufacturer.	25.00	26.06†	4.0	2.37	28.31	45	15	12	8
4712	Fine Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Treat & Clark, Orange.	33.00	34.30	3.7	2.06	27.99	70	18	12	--
4923	The Rogers & Hubbard Co.'s Strictly Pure Fine Bone.	The Rogers & Hubbard Co., Middletown.	Manufacturer.	30.00	30.65†	2.1	3.98	22.67	45	23	24	8
4612	Fine Ground Bone.	Bradley Fertilizer Co., Boston, Mass.	L. F. Judson, Stratford.	32.00	30.06	.2	3.77	19.24	59	29	12	--
			A. M. Clark, Scotland.	30.00	----	----	----	----	--	--	--	--
						Valuation equals cost.						
4902	The Rogers & Hubbard Co.'s Raw Knuckle Bone Meal.	The Rogers & Hubbard Co., Middletown.	Manufacturer.	37.00	36.99	----	3.75	26.35	60	27	13	--

* From stock bought by the Tobacco Experiment Co.

† See note on page 30.

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Bone Manures Sampled by Station Agent.— *Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.	Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Chemical Analysis.		Mechanical Analysis.			
							Nitrogen.	Phos. Acid.	Finer than			Coarser than $\frac{1}{4}$ inch.
									$\frac{1}{20}$ inch.	$\frac{1}{8}$ inch.	$\frac{1}{16}$ inch.	
						Cost exceeds Valuation.						
4774	The Rogers & Hubbard Co.'s Raw Knuckle Bone Flour.	The Rogers & Hubbard Co., Middletown.	S. E. Frisbie, Milford.	$40.00	$38.99	2.5	4.04	25.46	71	29	--	--
			J.P.Barstow & Co., Norwich.	39.00	----	----	----	----	--	--	--	--
4535	Swift Sure Bone Meal.	M. L. Shoemaker & Co., Philadelphia, Pa.	F. Ellsworth, Hartford.	40.00	38.47	4.0	5.60	23.19	53	30	17	--
4773	The Rogers & Hubbard Co.'s Strictly Pure Fine Bone.	The Rogers & Hubbard Co., Middletown.	Strong & Tanner, Winsted.	32.00	28.52†	5.1	4.18	21.21	28	34	32	6
			J.P.Barstow & Co., Norwich.	33.00	----	----	----	----	--	--	--	--
				30.00								
4897	Pure Ground Bone.	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	W. W. Sheldon, So. Woodstock.	36.00	34.14	5.4	4.09	24.29	45	33	22	--
4614	Pure Ground Bone.	Rogers Mfg. Co., Rockfall.	Manufacturer.	30.00	28.29	6.0	4.34	20.39	25	36	36	3
4781	White Oak Pure Ground Bone.	Clark's Cove Fertilizer Co., Boston, Mass.	John Dolbeare, Poquetanuck.	31.00	29.09	6.6	2.60	22.86	56	24	17	3
4882	Self-Recommending Fertilizer.	Frederick Nuhn, Waterbury.	Apothecaries Hall Co., Waterbury.	32.00	29.03†	10.2	3.66	24.18	47	15	12	26
4769	Bone Meal.	Williams & Clark Fertilizer Co., New York City.	D. B. Wilson, Waterbury.	34.00	30.68	10.8	3.18	23.14	49	29	22	--
4771	Pure Ground Bone.	Downs & Griffin, Birmingham.	F. L. Hallock & Co., Birmingham.	35.00	30.32	15.4	4.02	22.99	38	27	27	8
4903	Fine Ground Bone.	Standard Fertilizer Co., Boston, Mass.	J. W. Howe & Son, South Glastonbury.	35.00	29.56	18.4	3.90	19.87	49	27	24	--
4710	Pure Ground Bone.	Peck Bros., Northfield.	D. B. Wilson, Waterbury.	30.00	22.69	23.4	4.28	21.07	8	23	41	28
			Strong & Tanner, Winsted.	30.00	----	----	----	----	--	--	--	--
				28.00								
4891	Fine Ground Bone.	Pacific Guano Co., Boston, Mass.	Carlos Bradley & Son, Ellington.	35.00	24.28	44.1	2.28	18.17	59	24	17	--
4896	Extra Fine Ground Bone.	Cumberland Bone Phosphate Co., Boston, Mass.	Elliott Bros., Clinton.	36.00	20.91	72.1	2.16	15.67	55	21	24	--

† See note on page 30.

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3. *Sampled by Consumers.*

4647. Bone Meal. Made by the Danbury Fertilizer Co., Danbury. Sampled and sent by S. D. Woodruff & Sons, Orange. The manufacturer protested that this sample was from old stock which had been in Messrs. Woodruff & Sons' possession since the previous year and did not therefore represent their output of 1895.

4537. Bone Meal. Made by L. F. Frisbee & Co., Hartford. Sampled and sent by S. M. Wells, Wethersfield.

4532. Pure Ground Bone, made by the Rogers Manufacturing Co., Rockfall. Sampled and sent by S. A. Smith, Clintonville.

4737. Finely Ground Steamed Bone, sold by Geo. F. Taylor & Brush, New York City. Sampled and sent by H. C. C. Miles, Milford.

4541. Ground Bone, sold by G. F. Taylor & Brush. Sampled and sent by A. E. Plant, Branford.

4627. Fine Bone, bought of a New York broker by J. Norris Barnes, Yalesville.

MECHANICAL ANALYSES.

	4889	4647	4537	4532	4737	4541	4627
Fine, smaller than $\frac{1}{10}$ inch	62	44	52	65	70	82	79
Fine medium, smaller than $\frac{1}{5}$ inch	19	33	16	18	23	12	19
Medium, smaller than $\frac{1}{2}$ inch	11	23	11	12	6	5	2
Coarse, larger than $\frac{1}{2}$ inch	8	0	21	5	1	1	0
	100	100	100	100	100	100	100

CHEMICAL ANALYSES.

Nitrogen	2.74	3.94	3.54	2.83	2.82	3.00	2.06
Phosphoric acid	15.16	21.07	25.56	27.21	26.99	26.29	30.22
Cost per ton	$\$$----	29.00	25.00	28.00†	24.00	----	25.60*
Valuation per ton	$22.21	30.56	31.21	34.54	36.01	36.74	38.18

TANKAGE.

This name is applied to the sediment remaining in tanks where meat scrap and bone are cooked with water to separate the fat. After boiling or steaming, the fat rises to the surface and is removed, the soup is run off, and the settlings at the bottom are dried and sold as tankage. As the analyses show, "tankage" has no definite or constant composition. In general it contains more nitrogen and less phosphoric acid than bone.

* Car lot in Yalesville. † Several ton lot.

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Sampled by Station Agent.

4770. Armour's Special. Made by Armour Packing Co., Kansas City. From stock of F. C. Vibert, Hockanum.

4772. Bone Fertilizer, made by Plumb & Winton, Bridgeport. From stock of H. P. Folley, Danbury.

4547. Pulverized Tankage. Sold by L. Sanderson, New Haven.

4776. Blood, Bone and Meat. Sold by L. Sanderson, New Haven. From stock of Clifton Peck, Lebanon.

Sampled by Private Individuals.

4510. Tankage. Sold by National Fertilizer Co., Bridgeport. Sampled and sent by S. E. Curtis, Stratford.

4531. Tankage. Made by Plumb & Winton, Bridgeport. Sampled and sent by Dennis Fenn, Milford.

4761. Tankage. Sold by Read Fertilizer Co., New York City. Sampled and sent by Milo D. Beach, Litchfield.

4921. Tallow Scrap. Made by J. Maloney, East Haven. Sampled and sent by N. A. Haight, Fair Haven.

MECHANICAL ANALYSES.

	4770	4772	4547	4776	4510	4531	4761	4921
Fine, smaller than $\frac{1}{10}$ inch	65	57	60	64	52	65	61	52
Fine medium, smaller than $\frac{1}{15}$ inch	25	29	31	25	27	24	20	27
Medium, smaller than $\frac{1}{18}$ inch	10	14	9	11	15	11	14	14
Coarse, larger than $\frac{1}{18}$ inch	0	0	0	0	6	0	5	7
	100	100	100	100	100	100	100	100

CHEMICAL ANALYSES.

Nitrogen	6.96	4.98	5.10	6.01	8.87	5.41	6.62	7.17
Phosphoric acid	11.62	18.61	18.49	14.88	7.29	14.40	15.30	9.61
Cost per ton	$37.00	30.00	35.00	33.00	28.00	30.00	24.20*	30.00
Valuation per ton	$32.50	32.79	33.61	32.79	33.12	30.54	33.63	28.98

DRY GROUND FISH.

This residue from the extraction of fish oil is often sprinkled with diluted oil of vitriol to hinder decay during drying, and the fish bones are as a result softened and to some extent dissolved.

* Wholesale at Litchfield.

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4514. Made by G. W. Miles, Agent, Milford. Sampled by N L. & S. T. Merwin, Milford.

4760. Made by G. W. Miles, Agent. Sampled from stock of Olds & Whipple, Hartford.

4878. Sold by the Quinnipiac Co., Boston. Stock of Edmund Halliday, Suffield.

4548. Sold by L. Sanderson, New Haven, to the Station.

4671. Sold by L. Sanderson, to the Conn. Tobacco Experiment Co.

4639. Made by Leander Wilcox, Mystic. Sampled from stock of Lawrence Dailey, East Windsor Hill.

ANALYSES.

	4514	4760	4878	4548	4671	4639
Nitrogen as ammonia	.80	1.28	.46	.16	....	.16
Organic nitrogen	6.83	5.84	7.30	9.35	....	8.83
Total nitrogen	**7.63**	**7.12**	**7.76**	**9.51**	**9.26**	**8.99**
Water-soluble phosphoric acid	.88	.51	.64	.51	....	.74
Citrate-soluble (reverted) phosphoric acid	5.35	6.56	4.31	5.70	....	5.98
Insoluble phosphoric acid	1.82	.48	3.07	1.08	....	1.17
Total phosphoric acid	**8.05**	**7.55**	**8.02**	**7.29**	**7.36**	**7.89**
Cost per ton	$30.00	38.00	35.00	35.00	35.00	34.00
Valuation per ton	$33.17	32.03	32.53	38.75	....	37.67

MIXED FERTILIZERS.

Here are included all those fertilizers which have been compounded of two or more fertilizer chemicals or animal matters to make a mixture which usually contains the three fertilizer ingredients, nitrogen, phosphoric acid and potash.

BONE AND POTASH.

(See also certain mixtures of bone and potash with other chemicals referred to on page 49.)

4607. Bone and Potash, Square Brand. Made by the Bowker Fertilizer Co., Boston. Stock of Geo. Punzelt, Darien, and J. A. Paine, Danielsonville.

4606. Extra Fine Bone with Potash, Circle Brand. Made by Bradley Fertilizer Co., Boston. Stock of Raymond Bros., So. Norwalk.

4713. A. I. Fertilizer. Made by C. Buckingham, Southport. Stock of N. H. Sherwood, Southport.

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C. Buckingham protested that this analysis of his A. I. Fertilizer was lower than the average of the goods, which were guaranteed to contain 4 per cent. of nitrogen, 10 of phosphoric acid and 6 of potash. A second sample, No. **4859**, was therefore drawn from stock in Mr. Buckingham's possession.

4859. A. I. Fertilizer. Made by C. Buckingham, Southport. Sampled from stock of manufacturer.

4605. Ground Bone and Potash, made by the E. Frank Coe Co., New York City. Sampled from stock of E. S. Banks, Southport.

4865. Nameless Fertilizer made by the Danbury Fertilizer Co., Danbury. Sampled by Station agent from stock at the factory.

MECHANICAL ANALYSES.

	4607	4606	4713	4859	4605	4865
Fine, smaller than $\frac{1}{16}$ inch	68	60	72	68	57	76
Fine medium, smaller than $\frac{1}{8}$ inch	18	26	10	22	18	20
Medium, smaller than $\frac{1}{4}$ inch	13	14	7	8	14	3
Coarse, larger than $\frac{1}{4}$ inch	1	0	11	2	11	1
	100	100	100	100	100	100

CHEMICAL ANALYSES.

Nitrogen	1.94	2.53	2.82	3.30	2.13	4.06
Phosphoric acid	14.62	18.65	13.59	15.07	16.66	9.26
Potash, as Muriate	2.45	1.98	.60	3.21	2.27	4.76
Potash, as Sulphate	----	----	5.56	1.95	----	----
Potash, Total	2.45	1.98	6.16	5.16	2.27	4.76
Cost per ton	$32.00	33.00	35.00	35.00	26.00	30.00
Valuation per ton	$22.48	27.50	27.56	29.90	23.18	26.00

The two following samples, though sold under the name "Bone and Potash," contain only a quarter of one per cent. of nitrogen and therefore their brand is misleading:

4873. Soluble Bone and Potash, made by the Great Eastern Fertilizer Co., Rutland, Vt. Sampled from stock of E. T. Bates, Darien, and Silas Finch, Greenwich.

4714. Animal Bone and Potash, made by Lister's Agricultural Chemical Works, Newark, N. J. Sampled from stock of A. N. Clark, Milford.

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ANALYSES.

	4873	4714
Water-soluble phosphoric acid	5.36	6.72
Citrate-soluble (reverted) phosphoric acid	4.51	2.05
Insoluble phosphoric acid	1.81	.38
Total phosphoric acid	11.68	9.15
Potash, as muriate	2.01	5.28
Cost per ton	$25.00	26.00
Valuation per ton	13.92	15.22

II. NITROGENOUS SUPERPHOSPHATES AND GUANOS.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid and in most cases potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on.

1. *Samples drawn by Station Agents.*

In the tables on pages 40 to 47 are tabulated the analyses of seventy-seven brands, made on samples collected by the Station agents.

ANALYSES REQUIRING SPECIAL NOTICE.

The Eastern Farm Supply Association, Montclair, N. J., protested that analysis **4693**, Long Island Special, and **4694**, Cartaret Market Garden Manure, did not represent the average quality of these brands.

A re-test confirmed the accuracy of the Station analysis. It was not possible to get another sample of L. I. Special, but a second sample of the Market Garden Manure was analyzed and is **4906** in the table of analyses, page 40.

The Clark's Cove Fertilizer Co. protested that analysis **4743** was below their guarantee on all three ingredients. "We are positive that we have not sent goods of this grade into the market." A re-test confirmed the accuracy of our analysis. A second sample was, however drawn and analyzed, **4910**, and is given in the table, page 40. The second sample proved to be of much better quality.

The National Fertilizer Co. of Bridgeport requested another analysis of their Fish and Potash, **4849**, as the quantity of nitrogen in that sample was much lower than they expected the goods to contain.

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A second analysis, **4915,** was made, see page 42, which showed .4 per cent. more nitrogen, 1.6 more phosphoric acid and 1.4 per cent. less potash.

GUARANTEES.

Of the seventy-six analyses of nitrogenous superphosphates, in the table given on pages 40 to 47, twenty-one are below the maker's minimum guarantee in respect of one ingredient, five in respect of two and one in respect of all three ingredients. Thus more than one-third of the whole number do not fulfill in all respects the maker's claim for them.

It is urged that an excess of one ingredient over the guarantee should be held to make good the deficiency of another. But with reasonable care and skill in the manufacture and in the sampling and analysis of the goods, the actual analysis should not fall below the minimum guaranteed in any respect, particularly when wide limits are allowed in the guarantees themselves.

COST AND VALUATION.

Cost.

The method used to ascertain the retail cost price of the superphosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis, when done, is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

From the data thus obtained the average prices are computed.

Valuation.

The valuation has been computed in all cases in the usual manner as explained on page 16.

Percentage difference given in the table shows the percentage excess of the cost price over the average retail cost of the nitrogen, phosphoric acid and potash contained in the fertilizer.

This information enables the purchaser to estimate the relative value of the different brands and the relative economy of buying mixed fertilizers, or of procuring and compounding the materials needful for a fertilizer.

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Which plan is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

In case a fertilizer has sold at two or more different prices, the *manufacturer's price*, when known, has been used in calculating percentage difference.

Otherwise an *average, or nearly average price* forms the basis of comparison between cost and valuation. The price thus employed is printed in heavy-faced type.

The average cost of the nitrogenous superphosphates is $32.32. The average valuation is $23.37, and the percentage difference 38.2.

Last year the corresponding figures were:

Average cost $32.96, average valuation $23.30, percentage difference 41.3.

These valuations, it must be remembered, are based on the assumption that the nitrogen, phosphoric acid and potash in each fertilizer are readily available to farm crops. Chemical examination can show pretty conclusively whether this is true in respect of potash. There is less certainty regarding phosphoric acid, while chemical examination, as it is usually made, gives little or no clue as to the availability of the organic nitrogen of mixed goods. This Station has been for some years engaged in a study of methods for determining approximately the relative availability of nitrogen, and on subsequent pages is given a report of the work done during the past year on this point.

While various inferior or agriculturally worthless forms of nitrogen are in the market, the main security of purchasers of mixed fertilizers is in dealing with firms which have an established reputation and in avoiding "cheap" goods offered by irresponsible parties.

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Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4745	Potato and General Crop Fertilizer.	Chas. E. Lyman, Middlefield.	Manufacturer.	$36.00*
4906	Market Garden Manure.	Eastern Farm Supply Association, Montclair, N. J.	Paul Thompson, West Hartford.	32.00
4744	Bone, Fish and Potash.	E. R. Kelsey, Branford.	Samuel A. Chalker, Saybrook.	25.00
4785	Unexcelled Phosphate.	Geo. W. Miller, Middlefield.	Manufacturer.	30.00
4800	Old Reliable Superphosphate.	L. Sanderson, New Haven.	C. O. Jelliff & Co., Southport.	30.00
4756	Pure Fine Bone, Dissolved in Sulphuric Acid.	Mapes' Formula & Peruvian Guano Co., N. Y. City.	Mapes' Branch, Hartford.	32.00
4693	Carteret L. I. Special.	Eastern Farm Supply Association, Montclair, N. J.	N. H. Sherwood, Southport.	32.00 34.00
4749	Formula "A."	L. Sanderson, New Haven.	C. O. Jelliff & Co., Southport. Clifton Peck, Lebanon. Ira W. Beers, Hamden. J. Pierpont, North Haven.	35.00 36.00 35.00 35.00
4797	Ammoniated Dissolved Bone.	Williams & Clark Fertilizer Co., N. Y. City.	T. C. Greene, Torrington.	26.00
4750	Quinnipiac Market Garden Phosphate.	Quinnipiac Co., Boston, Mass.	A. P. Wakeman, Fairfield.	36.00
4829	IXL Ammoniated Bone Superphosphate.	Geo. W. Miles, Milford.	Manufacturer.	26.00
4725	Vegetable Bone Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Meeker Coal Co., Norwalk.	38.00
4679	Market Garden Phosphate.	Bowker Fertilizer Co., Boston, Mass.	E. B. Clark & Sons, Milford. Geo. Punzelt, Darien.	36.00 36.00
4716	Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	W. W. Cooper, Suffield. F. S. Bidwell, Windsor Locks.	36.00 35.00
4806	High Grade Fish and Potash.	Leander Wilcox, Mystic.	Browning & Gallup, New London.	32.00
4696	Complete Manure for Light Soils.	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford. Geo. K. Nason, Willimantic. Birdsey & Foster, Meriden. Dean & Horton, Stamford.	42.00 44.00 43.00 43.00
4658	Complete Manure, A Brand.	Mapes' F. & P. G. Co., N. Y. City.	Birdsey & Foster, Meriden. F. S. Bidwell, Windsor Locks. Quinnebaug Store, Danielsonville,	36.00 36.00 36.00 35.00
4759	Special Phosphate.	Olds & Whipple, Hartford.	Manufacturer.	35.00
4717	Animal Fertilizer, "G" Brand.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	F. S. Bidwell, Windsor Locks. Treat & Clark, Orange.	33.00 29.00 31.00
4910	Great Planet "A."	Clark's Cove Fertilizer Co., Boston, Mass.	H. A. Rogers & Co., New London.	36.00
4694	Cartaret Market Garden Manure.	Eastern Farm Supply Association, Montclair, N. J.	N. H. Sherwood, Southport.	32.00
4653	Complete Manure for General Use.	Mapes' F. & P. G. Co., N. Y. City.	Geo. K. Nason, Willimantic. Birdsey & Foster, Meriden. F. S. Bidwell, Windsor Locks. Dean & Horton, Stamford.	40.00 39.00 40.00 39.00

* The full-face figure is the one used in calculating the percentage difference.

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Analyses.

Per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrate.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
38	†8.3	....	....	2.47	2.47	*2.5*	3.66	5.70	1.23	10.59	....	9.36	*10.0*	10.09	10.09	*10.0*
56	4.7	....	2.70	1.48	4.18	*3.3*	3.15	4.86	.82	8.83	*8.0*	8.01	*7.0*	1.03	6.08	*7.0*
32	7.2	....	.64	3.06	3.70	*3.3*	2.43	2.43	.23	5.09	*4.0*	4.86	....	.60	5.01	*4.0*
96	7.3	....	....	2.16	2.16	*1.5*	4.27	6.58	1.39	12.24	*11.5*	10.85	....	8.79	8.79	*8.0*
79	11.9	.13	....	2.39	2.52	*1.7*	4.75	5.29	1.65	11.69	*10.0*	10.04	*7.0*	3.13	3.13	*2.0*
64	15.7	....	....	2.40	2.40	*2.1*	6.48	10.72	.38	17.58	....	17.20	*12.0*	.....	.....	....
91	17.6	....	....	3.26	3.26	*3.5*	4.80	4.50	.61	9.91	*8.5*	9.30	*7.5*	8.00	8.00	*8.0*
50	18.6	.50	.59	2.93	4.02	*3.3*	3.01	5.27	2.36	10.64	*10.0*	8.28	*6.0*	6.44	6.44	*6.0*
84	19.0	....	....	2.08	2.08	*1.7*	4.56	6.22	2.06	12.84	*9.0*	10.78	*8.0*	2.06	2.06	*2.0*
03	19.9	.59	1.30	1.75	3.64	*3.3*	5.20	4.06	1.61	10.87	*9.0*	9.26	*8.0*	4.47	6.66	*7.0*
59	20.4	....	.94	2.04	2.98	*2.1*	4.88	1.94	2.61	9.43	*9.0*	6.82	*8.0*	2.61	2.61	*2.0*
19	21.8	1.05	....	4.33	5.38	*5.0*	4.96	1.70	.27	6.93	*6.0*	6.66	*5.0*	6.47	6.47	*6.0*
22	23.2	1.23	....	1.61	2.84	*2.5*	6.24	3.10	2.98	12.32	*8.0*	9.34	*8.0*	9.03	9.03	*10.0*
81	23.6	.30	.15	2.85	3.30	*3.0*	2.51	8.33	2.43	13.27	*10.0*	10.84	*6.0*	4.78	4.78	*4.0*
66	24.7	....	.41	3.81	4.22	*3.3*	2.83	3.84	.31	6.98	*6.0*	6.67	*5.0*	4.25	4.25	*4.0*
65	24.8	1.51	1.24	2.42	5.17	*4.9*	5.07	3.54	.40	9.01	*8.0*	8.61	*6.0*	7.12	7.12	*6.0*
28	28.2	.45	.22	2.28	2.95	*2.5*	6.16	6.41	.61	13.18	*12.0*	12.57	*10.0*	3.24	3.24	*2.5*
18	28.7	....	.07	3.06	3.13	*3.0*	6.68	5.27	1.58	13.53	*10.0*	11.95	*9.0*	.40	2.31	*2.0*
92	29.5	....	.14	2.51	2.65	*1.7*	1.41	7.79	1.88	10.08	*7.0*	9.20	....	4.57	4.57	*4.0*
33	29.6	1.32	....	2.52	3.84	*3.3*	5.04	3.53	2.22	10.79	*9.0*	8.57	*8.0*	6.92	6.92	*7.0*
47	30.7	....	.60	1.84	2.44	*3.0*	3.95	6.11	1.01	11.07	*8.0*	10.06	*7.0*	4.80	4.80	*7.0*
42	32.5	.91	.58	2.25	3.74	*3.3*	5.18	6.01	.64	11.83	*10.0*	8.92	*8.0*	4.47	4.47	*4.0*

* See note, p. 37.

† Valuation exceeds cost.

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Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4827	Harvest Home.	H. J. Baker & Bro., N. Y. City.	S. J. Hall, Meriden.	$27.00
4533	Swift Sure Superphosphate.	M. L. Shoemaker & Co., Philadelphia, Pa.	F. Ellsworth, Hartford.	38.00
4813	Standard Complete.	Standard Fertilizer Co., Boston, Mass.	I. H. Bushnell, Jewett City.	39.00
4791	High Grade General Fertilizer.	Pacific Guano Co., Boston, Mass.	S. R. Jones, Deep River.	40.00
4807	Ammoniated Bone Phos-Phate.	Leander Wilcox, Mystic.	Browning & Gallup, New London.	34.00
			Mandy Gray, Poquetanuck.	32.00
				33.00
4821	Fish and Potash, Triangle "A" Brand.	Bradley Fertilizer Co., Boston, Mass.	S. A. Billings, Meriden.	30.00
4805	Complete Bone Superphosphate.	Leander Wilcox, Mystic.	Browning & Gallup, New London.	31.00
4618	Complete Fertilizer.	Rogers Mfg. Co., Rockfall.	Manufacturer.	35.00
4636	A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., N. Y. City.	E. White, Rockfall.	40.00
			C. O. Jelliff & Co., Southport.	34.00
				35.00
4864	Ammoniated Bone Superphosphate.	Preston Fertilizer Co., Greenpoint, L. I.	S. D. Keeler, Ridgefield.	34.00
4802	Fish, Bone and Potash.	Read Fertilizer Co., N. Y. City.	W. Tillinghast, Plainfield.	30.00
			Fred. R. Tryon, Middletown.	28.00
			N. S. Lee, Old Lyme.	32.00
4915	Chittenden's Fish and Potash	National Fertilizer Co., Bridgeport.	Manufacturer.	32.00
4721	Standard Phosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	Geo. W. Dennison, Saybrook.	33.00
			A. N. Clark, Milford.	32.00
4652	Ammoniated Dissolved Bone or Farm and Garden Phosphate.	Bowker Fertilizer Co., Boston, Mass.	E. B. Clark & Sons, Milford.	28.00
			J. A. Lewis, Willimantic.	37.00
			Hubbell & Bradley.	32.00
				36.00
4743	Great Planet "A."	Clark's Cove Fertilizer Co., Boston, Mass.	John Dolbeare, Poquetanuck	38.00
4722	Quinnipiac Phosphate.	Quinnipiac Co., Boston, Mass.	F. S. Bidwell, Windsor Locks	35.00
			Meeker Coal Co., Norwalk.	36.00
			G. G. Tillinghast, Vernon.	33.00
			A. P. Wakeman, Fairfield.	34.00
4699	Success Fertilizer.	Lister's Agricultural Chemical Works, Newark, N. J.	J. A. Foster, Stafford.	31.00
			E. F. Hutchinson, Andover.	30.00
			A. N. Clark, Milford.	26.00
				28.00
4789	Americus Brand Ammoniated Bone Superphosphate.	Williams & Clark Fertilizer Co., N. Y. City.	T. C. Greene, Torrington.	34.00
			Bulkley & Hanmer, Wethersfield.	35.00
			D. B. Wilson, Waterbury.	35.00
			Hale, Day & Co., So. Manchester.	36.00
			W. B. Martin, Rockville.	34.00
			John Bransfield, Portland.	35.00

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ANALYSES.— *Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen. Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$20.33	32.8	....	.61	1.17	1.78	*1.0*	5.20	4.94	1.11	11.25	*8.0*	10.14	....	2.34	2.34	*2.0*
28.51	33.2	.70	....	2.26	2.96	....	6.86	4.26	3.66	14.78	....	11.12	....	.....	4.35	....
29.05	34.2	1.30	....	2.42	3.72	*3.3*	4.80	4.34	1.48	10.62	*9.0*	9.14	*8.0*	6.71	6.71	*7.0*
29.56	35.3	.69	.61	2.42	3.72	*3.3*	4.45	4.80	1.36	10.61	*9.0*	9.25	*8.0*	6.76	6.76	*7.0*
24.32	35.6	.22	.27	2.76	3.25	*2.5*	4.56	2.93	.38	7.87	*7.0*	7.49	*6.0*	5.23	5.23	*5.0*
22.08	35.8	....	.14	2.17	2.31	*2.0*	6.08	3.33	1.48	10.89	*6.0*	9.41	*4.0*	3.16	3.16	*4.0*
22.80	35.9	.26	....	2.30	2.56	*2.0*	6.29	3.31	.70	10.30	*9.0*	9.60	*8.0*	3.29	3.29	*3.0*
25.57	36.8	.98	....	1.69	2.67	*2.2*	5 07	5.95	1.07	12.09	*10.0*	11.02	....	.47	3.87	*5.0*
25.08	39.5	.48	1.08	1.14	2.70	*2.5*	8.62	2.63	.65	11.90	....	11.25	*10.0*	2.66	2.66	*2.0*
24.01	41.6	....	.26	1.90	2.16	*2.5*	4.99	3.81	1.11	9.91	*9.0*	8.80	....	1.43	6.07	*2.0*
21.15	41.8	.10	....	2.73	2.83	*2.5*	3.55	1.66	.35	5.56	*6.0*	5.21	*4.0*	6.23	6.23	*4.0*
†22.55	41.9	....	....	2.62	2.62	*2.9*	2.72	5.89	1.73	10.34	*8.0*	8.61	....	3.86	3.86	*4.0*
22.43	42.6	....	.30	2.12	2.42	*1.9*	7.50	2.35	2.30	12.15	*12.0*	9.85	*10.0*	2.01	2.01	*1.5*
20.94	43.2	.35	....	1.53	1.88	*1.5*	6.24	3.92	2.11	12.27	*10.0*	10.16	*8.0*	1.75	2.34	*2.0*
*26.49	43.4	1.26	....	1.98	3.24	*3.3*	5.97	1.93	.63	8.53	*9.0*	7.90	*8.0*	3.61	6.85	*7.0*
24.29	44.0	.54	....	2.26	2.80	*2.5*	6.59	4.36	1.40	12.35	*10.0*	10.95	*9.0*	2.15	2.15	*2.0*
19.41	44.2	....	.22	1.40	1.62	*1.2*	7.49	2.02	2.13	11.64	....	9.51	*9.5*	2.13	2.13	*2.0*
24.22	44.5	.40	....	2.43	2.83	*2.5*	7.04	3.73	1.38	12.15	*10.0*	10.77	*9.0*	2.11	2.11	*2.0*

* See note, p. 37.

† See page 38.

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Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4681	Farmer's New Method Fertilizer.	Bradley Fertilizer Co., Boston, Mass.	Wilson & Burr, Middletown.	$32.00
			J. A. Lewis, Willimantic.	33.00
			Quinnebaug Store.	34.00
			G. W. Carver, Putnam.	31.00
4678	Hill and Drill Phosphate.	Bowker Fertilizer Co., Boston, Mass.	Crawford & Devine, Uncasville.	38.00
			W. B. Martin, Rockville.	36.00
			J. A. Paine, Danielsonville.	36.00
4871	Concentrated Phosphate.	Cumberland Bone Phosphate Co, Boston, Mass.	John Parker, Poquonock.	40.00
4740	Bay State Fertilizer, "G" Brand.	Clark's Cove Fertilizer Co., Boston, Mass.	H. H. Davenport, Pomfret.	30.00
			J. M. Burke, South Manchester.	34.00
				32.00
4682	Bradley's Patent Superphosphate.	Bradley Fertilizer Co., Boston, Mass.	J. A. Lewis, Willimantic.	35.00
			H. H. Davenport, Pomfret.	34.00
			Quinnebaug Store, Danielsonville.	36.00
			G. W. Carver & Son, Putnam.	34.00
			Raymond Bros., South Norwalk.	35.00
			W. B. Martin, Rockville.	35.00
			R. A. Parker, Warehouse Pt.	35.00
			F. S. Bidwell, Windsor Locks	35.00
			W. W. Cooper, Suffield.	36.00
4847	Chittenden's Ammoniated Bone Phosphate.	National Fertilizer Co., Bridgeport.	Manchester Elevator Co., Manchester.	33.00
			T. H. Eldridge, Norwich.	34.00
			G. A. & H. G. Williams, E. Hartford.	31.00
			Andrew Ure, New Haven.	30.00
				32.00
4651	High Grade Ammoniated Bone Superphosphate.	The E. Frank Coe Co., N. Y. City.	Hillhouse & Taylor, Willimantic.	35.00
			W. F. Palmer, Scotland.	34.00
			E. S. Banks, Southport.	31.00
				32.00
4834	Bay State Fertilizer.	Clark's Cove Fertilizer Co, Boston, Mass.	White & Juno, Rockville.	36.00
4846	Fish and Potash, Crossed Fishes Brand.	Quinnipiac Co., Boston, Mass	F. S. Bidwell, Windsor Locks	36.00
4842	Ammoniated Bone Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	J. P. Little, Columbia.	35.00
4747	Alkaline Bone.	E. Frank Coe Co., N. Y. City.	J. O. Fox & Co., Putnam.	30.00
4786	Fish and Potash.	Pacific Guano Co., Boston, Mass.	Edmund Halladay, Suffield.	32.00
4794	Soluble Pacific Guano.	Pacific Guano Co., Boston, Mass.	Saxton & Strong, Bristol.	36.00
			John Bransfield, Portland.	35.00
			R. F. Woodford, Plainville.	35.00
			P. F. Walsh, Montville.	34.00
			T. B. Wickwire, Berlin.	38.00
4754	High Grade Triumph.	Niagara Fertilizer Works, Buffalo, N. Y.	Wm. H. Loomis, Bolton.	33.00
			Wm. Higgins, New London.	32.00

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ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$22.09	44.8	.09	....	2.22	2.31	*1.7*	6.58	2.87	1.03	10.48	*10.0*	9.45	*8.0*	3.36	3.36	*3.0*
24.79	45.2	.60	....	2.04	2.64	*2.5*	7.81	4.04	1.28	13.13	*10.0*	11.85	*9.0*	2.16	2.16	*2.0*
27.51	45.4	1.33	....	2.21	3.54	*4.0*	4.72	3.95	1.68	10.35	*10.0*	8.67	*8.0*	6.18	6.18	*7.0*
21.76	47.0	....	.13	2.25	2.38	*1.9*	7.30	2.23	.88	10.41	*10.0*	9 53	*6.5*	2.54	2.54	*2.0*
23.73	47.4	.44	....	2.31	2.75	*2.3*	7.44	2.95	.98	11.37	*11.0*	10.39	*9.0*	2.47	2.47	*1.5*
21.65	47.8	....	.22	2.10	2.32	*2.0*	1.70	8.90	.67	11.27	*9.0*	10.60	....	2.02	2.02	*2.0*
21.61	48.0	....	....	2.10	2.10	*2.0*	7.95	2.18	1.90	12.03	*9.0*	10.13	*9.0*	.18	1.91	*1.9*
23.96	50.2	.63	....	2.18	2.81	*2.5*	8.40	1.87	.86	11.13	*10.0*	10.27	*9.0*	.49	2.36	*2.0*
23.93	50.4	.43	.19	2.56	3.18	*3.3*	3.79	3.32	1.81	8.92	*5.0*	7.11	*3.0*	5.08	5.08	*4.0*
23.19	50.9	....	....	2.92	2.92	*2.9*	7.84	2.76	.34	10.94	*11.0*	10.60	*10.0*	1.07	1.07	*1.0*
19.74	51.9	....	....	1.50	1.50	*1.0*	6.80	2.79	2.49	12.08	*9.0*	9.59	*7.0*	.49	2.51	*3.0*
20.94	52.8	....	....	2.38	2.38	*2.5*	2.30	4.92	1.93	9.15	....	7.22	*6.0*	4.61	4.61	*4.0*
22.90	52.8	.26	....	2.36	2.62	*2.3*	6.51	3.80	1.41	11.72	*10.5*	10.31	*8.5*	1.98	1.98	*2.0*
20.67	54.8	....	....	2.58	2.58	*2.5*	5.68	2.48	1.24	9.40	*9.0*	8.16	*8.0*	2.34	2.34	*2.2*

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Nitrogenous Superphosphates and Guanos, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4825	Cleveland Superphosphate.	Cleveland Dryer Co., Boston, Mass.	Chas. E. Scranton, Madison.	$33.00
4809	Standard Fertilizer.	Standard Fertilizer Co., Boston, Mass.	Arnold Warner, So. Coventry.	34.00
4742	King Philip Alkaline Guano.	Clark's Cove Fertilizer Co., Boston, Mass.	John Dolbeare, Poquetanuck	27.00
			H. H. Davenport, Pomfret.	28.00
			J. M. Burke, So. Manchester.	29.00
4812	Standard Superphosphate.	Standard Fertilizer Co., Boston, Mass.	W. E. Truesdell & Co., Burnside.	40.00
4720	Ammoniated Dissolved Bone Phosphate.	Lister's Agricultural Chemical Works, Newark, N. J.	J. A. Foster, Stafford.	32.00
4687	Smoky City.	Walker, Stratman & Co., Pittsburgh, Pa.	E. White, Rockville.	32.00
4739	Fish and Potash, "D" Brand.	Joseph Church & Co., Tiverton, R. I.	W. W. Cooper, Suffield.	32.00
			J. P. Barstow & Co., Norwich	30.00
				31.00
4656	B. D. Sea Fowl Guano.	Bradley Fertilizer Co., Boston, Mass.	R. A. Parker, Warehouse Point.	35.00
			F. S. Bidwell, Windsor Locks	33.00
			W. W. Cooper, Suffield.	36.00
4684	New Rival Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	W. C. Latimer, So. Coventry	34.00
			Henry Davis, Durham Center.	27.00
				31.00
4787	Royal Bone Phosphate.	Williams & Clark Fertilizer Co., N. Y. City.	Hale, Day & Co., So. Manchester.	33.00
				28.00
4793	Nobsque Guano.	Pacific Guano Co., Boston, Mass.	S. R. Jones, Deep River.	32.00
			T. B. Wickwire, Berlin.	29.00
			P. F. Walsh, Montville.	30.00
4634	Sure Crop Phosphate.	Bowker Fertilizer Co., Boston, Mass.	W. Tillinghast, Plainfield.	30.00
			F. S. Bidwell, Windsor Locks	28.00
			Hubbell & Bradley, Saugatuck.	30.00
4849	Chittenden's Fish and Potash	National Fertilizer Co., Bridgeport.	T. H. Eldridge, Norwich.	34.00
			N. C. Barker & Co., Lebanon.	32.00
4798	Standard Phosphate.	Read Fertilizer Co., N. Y. City.	W. Tillinghast, Plainfield.	30.00
			N. S. Lee, Old Lyme.	32.00
			Fred. R. Tryon, Middletown.	28.00
4843	Farmer's Reliable.	Chicopee Guano Co., N. Y. City.	Patrick Ahern, East Windsor Hill.	35.00
4815	Cumberl'd Superphosphate.	Cumberland Bone Phosphate Co., Boston, Mass.	Elliott Bros., Clinton.	38.00
4840	Fish and Potash.	Williams & Clark Fertilizer Co., N. Y. City.	L. J. Grant, Wapping.	33.00
4796	Economical Bone Fertilizer.	Wilkinson & Co, N. Y. City.	Wales Peck, Peck Hill, Woodbridge.	33.00
4822	Practical Superphosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	W. W. Sheldon, So. Woodstock.	30.00
4804	Standard Guano.	Standard Fertilizer Co., Boston, Mass.	Arnold Warner, So. Coventry.	34.00
4686	Four Fold Fertilizer.	Walker, Stratman & Co., Pittsburgh, Pa.	E. White, Rockville.	32.00
				30.00
4816	Cumberland Fertilizer.	Cumberland Bone Phosphate Co., Boston, Mass.	Elliott Bros., Clinton.	35.00
4824	Cereal Brand.	F. L. Ludlam, N. Y. City.	J. L. Appeley, Canterbury.	†....

† Asked but not given.

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ANALYSES.— *Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.						Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen. Found.	Total Nitrogen. Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found. As Muriate.	Found. Total.	Guaranteed.
$21.19	55.7	....	.18	2.28	2.46	*2.1*	4.59	4.29	2.17	11.05	....	9.88	*9.0*	2.11	2.11	*2.0*
21.72	56.5	....	....	2.48	2.48	*2.0*	7.30	2.03	.71	10.04	*10.0*	9.33	*8.0*	2.52	2.52	*2.0*
17.69	58.2	....	....	1.38	1.38	*1.0*	6.19	2.84	1.14	10.17	*9.0*	9.03	*8.0*	2.35	2.35	*2.0*
25.18	58.8	1.20	....	2.10	3.30	*2.5*	8.00	2.27	.57	10.84	*11.0*	10.27	*9.0*	1.56	2.43	*2.0*
20.14	58.8	....	.30	1.60	1.90	*1.7*	6.66	2.87	2.56	12.09	....	9.53	*9.0*	1.75	1.75	*2.0*
20.10	59.2	....	....	1.36	1.36	*1.2*	10.48	2.32	.33	13.13	*15.0*	12.80	*12.0*	.26	.37	*1.0*
19.44	59.4	....	.18	2.40	2.58	*2.1*	3.60	3.53	1.26	8.39	*7.5*	7.13	*6.0*	2.39	2.39	*2.0*
21.80	60.5	.39	....	1.84	2.23	*2.1*	5.15	5.55	1.86	12.56	*10.0*	10.70	*8.0*	1.70	1.70	*1.5*
18.80	64.8	....	....	1.42	1.42	*1.2*	6.77	3.67	1.25	11.69	*11.0*	10.44	*10.0*	1.61	1.61	*1.6*
16.89	65.7	....	....	1.16	1.16	*1.0*	5.12	4.26	1.21	10.59	*8.0*	9.38	*7.0*	1.94	1.94	*2.0*
17.96	67.0	....	....	1.37	1.37	*1.2*	2.03	7.51	1.74	11.28	*9.0*	9.54	....	2.27	2.27	*2.0*
17.87	67.8	.22	....	.90	1.12	*.8*	4.41	5.97	3.36	13.74	*10.0*	10.38	*8.0*	1.16	1.16	*1.0*
*19.05	67.9	....	....	2.20	2.20	*2.9*	1.58	3.11	4.03	8.72	*6.0*	4.69	....	4.34	5.25	*4.0*
17.62	70.2	....	....	1.08	1.08	*.8*	6.69	1.92	.46	9.07	*10.0*	8.61	*8.0*	4.16	4.16	*4.0*
20.21	73.1	....	....	2.10	2.10	*1.7*	6.24	2.97	2.59	11.80	*9.0*	9.21	*8.0*	1.64	1.64	*2.0*
21.27	78.6	.15	....	2.15	2.30	....	7.01	2.32	1.06	10.39	*10.0*	9.33	*8.0*	2.60	2.60	*2.0*
18.46	78.7	....	.22	2.05	2.27	*2.5*	2.99	2.86	2.27	8.12	*6.0*	5.85	*4.0*	1.81	3.33	*4.0*
17.87	79.0	....	....	1.36	1.36	*1.2*	4.86	3.59	2.50	10.95	*7.0*	8.45	*7.0*	2.89	2.89	*3.0*
16.38	83.1	....	....	1.02	1.02	*.8*	4.48	4.67	3.20	12.35	*8.0*	9.15	*8.0*	1.34	1.34	*1.0*
17.05	99.4	....	....	1.20	1.20	*1.0*	6.03	2.90	1.13	10.06	*10.0*	8.93	*8.0*	2.45	2.45	*2.0*
14.06	113.3	....	....	1.11	1.11	*.8*	5.81	1.50	1.02	8.33	*11.0*	7.31	*8.0*	1.52	1.52	*1.0*
17.60	115.9	....	....	1.08	1.08	*1.0*	4.73	5.20	1.84	11.77	*10.0*	9.93	*8.0*	2.11	2.11	*2.0*
18.78	.....	.20	....	.97	1.17	*.8*	5.84	5.00	3.16	14.00	*10.0*	10.84	*8.0*	1.34	1.34	*1.0*

* See note, p. 37.

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2. *Sampled by the Manufacturer.*

In the following table are four analyses made on samples deposited with the Director of the Station by manufacturers in compliance with the requirements of the Fertilizer Law.

The brands named were not found in the Connecticut market by our sampling agents. They are the following:

4884. Anchor Brand Fish and Potash, made by Bradley Fertilizer Co., Boston.

4888. Original Coe's Superphosphate, made by Bradley Fertilizer Co., Boston.

4887. Great Eastern General Fertilizer, made by Great Eastern Fertilizer Co., Rutland, Vt.

4845. Cecrops Fertilizer, Cecrops or Dragon's Tooth Brand, made by Frederic Ludlam, N. Y.

3. *Sampled by Consumers.*

In the following table are three analyses made on samples of this kind. The Station is not responsible for the accuracy of the sampling, though in each case it holds the written statement of the sampler that the Station's directions for sampling were followed.

The three following are of goods made by the Cumberland Bone Phosphate Co., Boston, Mass., and were drawn by D. C. Spencer, Saybrook.

4689, Concentrated Phosphate; **4691,** Cumberland Superphosphate, and **4692,** Cumberland Fertilizer.

	4884	4888	4887	4845	4689	4691	4692
Nitrogen of nitrates	....	.15	....	1.39	1.53	.10	....
Organic nitrogen	3.66	2.35	1.26	1.17	2.02	2.23	1.30
Total nitrogen	**3.66**	**2.50**	**1.26**	**2.56**	**3.55**	**2.33**	**1.30**
Soluble phosphoric acid	3.31	7.44	6.89	5.12	5.42	6.75	5.09
Reverted phosphoric acid	3.00	2.61	3.20	4.44	4.75	2.72	3.98
Insoluble phosphoric acid	1.74	1.31	1.96	2.06	1.25	1.05	1.20
Total phosphoric acid	**8.05**	**11.36**	**12.05**	**11.62**	**11.42**	**10.52**	**10.27**
Potash as muriate	3.47	2.44	4.44	7.21	6.64	2.37	2.06
Potash as sulphate	.21	....	....	....	....	....	....
Total potash	**3.68**	**2.44**	**4.44**	**7.21**	**6.64**	**2.37**	**2.06**
Cost per ton	....	....	....	....	$38.00	32.00	28.00
Valuation per ton	$23.39	22.73	20.73	26.36	29.47	21.30	17.11

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III. Special Manures.

For Analyses and Valuations see pages 52 to 60.

Here are included such mixed fertilizers, chiefly nitrogenous superphosphates, as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

1. *Samples drawn by Station Agents.*

In the tables on pages 52 to 59, are tabulated the analyses of seventy-eight brands made on samples drawn by the Station agents.

Analyses which require Special Notice.

4746. Lyman's Corn Manure is designed for use with stable manure and as supplementary to it.

Nos. **4879, 4881, 4901, 4609, 4880, 4608,** are mixtures of chemicals and ground bone and apparently contain no other forms of phosphate.

4608 consists of a mixture of ground bone and potash salts alone, and would be classed with other samples of bone and potash (see page 35) were it not branded as a fertilizer for particular crops.

The manufacturers of **4695,** Cartaret Potato Manure, protested that this analysis did not fairly represent the quality of the brand and asked that another sample be drawn from a different lot of the fertilizer. A re-test proved the correctness of the analysis. The analysis of a second sample, drawn in compliance with the manufacturer's request, No. **4905,** appears on page 52. This latter analysis contains somewhat less nitrogen than the former, and more than twice as much potash.

L. Wilcox protested that the analysis **4808,** his Potato, Onion and Tobacco Manure, did not fairly represent the average quality of this brand, which contained over 6 per cent. of potash. A re-test proved the correctness of our analysis. The Station endeavored to find other lots of this brand in market from which to draw samples, but was unable to do so.

The Bradley Fertilizer Co. protested that the per cent. of nitrogen found in analysis **4659,** Complete Manure for Potatoes and Vegetables, was below what the goods on the average contained,

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and requested a re-test. A re-test proved the correctness of our analysis. The Station agents drew three other samples on which analysis **4998**, page 54, was made, which showed about .3 per cent. more nitrogen, and a per cent. less of phosphoric acid.

The Bradley Fertilizer Co. also protested that analysis **4837**, High Grade Tobacco Manure, showed less nitrogen than the goods were calculated to contain. A re-test confirmed the analysis, but the Station agents were not able to find other samples on which another analysis could be made.

The Niagara Fertilizer Works protested that the analysis of **4752**, Potato, Hop and Tobacco Fertilizer, misrepresented the quality of the goods, which contained over three times the quantity of nitrogen reported (.54 per cent.). A re-test of the sample proved the correctness of our analysis. Nitrogen was therefore determined in three other samples drawn from as many different stocks. The percentages of nitrogen found (.48, .56 and .47) were essentially the same as found in the first analysis.

M. E. Wheeler & Co. protested that analysis No. **4874**, Grain and Oats Fertilizer, totally misrepresented the average quality of the brand and led them to think that our sampling agent drew something which was not their goods. Re-test confirmed the accuracy of our analysis. The sampling agents were unable to find other samples of this brand in market, but an analysis was made of the sample deposited by the manufacturer earlier in the season, with the results given on page 60, No. **4914**. This latter analysis is much higher both in phosphoric acid and potash than the former.

Guarantees.

Of the seventy-eight brands of special manures here tabulated nineteen are below the manufacturers' guarantee in respect of one ingredient and ten in respect of two ingredients, so that in all, considerably more than one-third of the whole number do not in all respects fulfill the manufacturers' claims.

Cost, Valuation and Percentage Difference.

Rejecting from calculation the last three analyses in the tables, the average cost of 75 Special Manures was $37.33 per ton. The average valuation was $27.94. The difference, $9.39, is equivalent to a "percentage difference"* of 33.6.

Last year the corresponding figures were, average cost $38.13, average valuation 28.62, percentage difference 33.2.

* See page 38.

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As will be seen by reference to page 6, Messrs. Mason, Chapin & Co., of Providence, R. I., have entered six brands of fertilizers for sale in this State. Our sampling agents were able to find only three of them, of which the analyses are given on pages 58 and 59. As the manufacturers failed to deposit sealed samples at the Station, it has not been possible to make analyses of the other three brands.

2. *Sampled by Manufacturers, and* 3. *Sampled by Consumers.*

Analyses on page 60.

2. *Sampled by Manufacturers.*

These samples were sent to the Station in compliance with the terms of the Fertilizer Law, and were analyzed because no samples of the brands named were found in market by our sampling agents.

4886. Special Conn. Tobacco Manure, made by the Crocker Fertilizer Co., Buffalo. The manufacturer protests that the per cent. of nitrogen found is lower than the goods on the average contain. Re-test proved the correctness of our analysis.

4883. Garden and Lawn Fertilizer, made by L. B. Darling Fertilizer Co., Pawtucket.

4885. Lister's Special Tobacco Fertilizer, made by Lister's Agricultural Chemical Works, Newark, N. J.

4914. Grass and Oats Fertilizer, made by M. E. Wheeler & Co., Rutland, Vt.

3. *Sampled by Consumers.*

The Station is not responsible for the accuracy of samples of this kind, though it holds the written statement of the sampler that the sampling was done according to the Station's directions.

4690. Cumberland Potato Manure, made by Cumberland Bone Phosphate Co., Boston. Sampled and sent by D. C. Spencer, Saybrook.

4610, Fairchild's Formula for Corn and General Crops. **4611,** The Rogers & Hubbard Co.'s Fertilizer for Oats and Top Dressing. **4619,** Soluble Tobacco Manure, and **4620,** Soluble Potato Manure, all made by the Rogers & Hubbard Co., Middletown. Sampled and sent by F. H. Lockwood, New Canaan.

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Special Manures, Sampled by the Station.

Station No.	Name or Brand.	Manufacturer	Dealer.	Dealer's Cash Price per Ton.
4746	Corn Manure.	Chas. E. Lyman, Middlefield	Manufacturer.	$21.00
4616	High Grade Fertilizer for Oats and Top-Dressing.	Rogers Mfg. Co., Rockfall.	Manufacturer.	42.00
4879	Fairchild's Formula for Corn and General Crops.	Rogers & Hubbard Co., Middletown.	S. E. Frisbie, Milford. J. P. Barstow & Co., Norwich.	46.00 48.00
4866	Rogers & Hubbard Co's Soluble Tobacco Manure.	Rogers & Hubbard Co, Middletown.	S. E. Frisbie, Milford.	42.00
4881	Seeding Down Manure.	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford.	37.50
4901	Rogers & Hubbard Co's Grass and Grain Fertilizer	Rogers & Hubbard Co., Middletown.	Manufacturer.	36.50
4617	Soluble High Grade Potato and General Crop Manure.	Rogers Mfg. Co., Rockfall.	Manufacturer.	38.00
4609	High Grade Corn Fertilizer.	Rogers Mfg. Co., Rockfall.	Manufacturer.	46.00
4905	Potato Manure.	Eastern Farm Supply Association, Montclair, N. J.	Paul Thompson, West Hartford,	30.00
4872	Potato Fertilizer.	Danbury Fertilizer Co., Danbury.	Manufacturer. E. Baker, Greens Farms.	35.00 32.00 33.50
4867	Rogers & Hubbard Co's Soluble Potato Manure.	Rogers & Hubbard Co., Middletown.	John Bransfield, Portland. J. P. Barstow, Norwich. S. E. Frisbie, Milford. G. M. Smith & Co., Rocky Hill.	38.00 40.00 38.00 38.00
4880	Rogers & Hubbard Co's Fertilizer for Oats and Top-Dressing.	Rogers & Hubbard Co., Middletown.	John Bransfield, Portland. S. E. Frisbie, Milford.	50.00 50.00
4635	Complete Potato Manure.	H. J. Baker & Bro., N. Y. City.	C. O. Jelliff & Co., Southport. E. White, Rockville.	38.00 40.00
4680	Onion Manure.	H. J. Baker & Bro., N. Y. City.	D. N. Benton, Guilford. C. O. Jelliff & Co., Southport.	40.00 38.00 39.00
4715	Potato and Root Crop Manure.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	F. S. Bidwell, Windsor Locks	38.00
4828	Special Tobacco Manure.	H. J. Baker & Bro., N. Y. City.	W. F. Andross, East Hartford.	40.00
4718	Tobacco Grower.	L. B. Darling Fertilizer Co., Pawtucket. R. I.	F. S. Bidwell, Windsor Locks	40.00
4657	Stockbridge Top-Dressing.	Bowker Fertilizer Co., Boston, Mass.	W. B. Martin, Rockville. J. A. Paine, Danielsonville.	40.00 40.00
4758	Tobacco Manure, Wrapper Brand.	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford.	48.00
4757	Tobacco Starter.	Mapes' F. & P. G. Co., N. Y. City.	Mapes' Branch, Hartford.	35.00
4608	High Grade Fertilizer for Grass and Grain.	Rogers Mfg. Co., Rockfall.	Manufacturer.	38.00
4830	Havana Tobacco Fertilizer.	Quinnipiac Co., Boston, Mass.	O. S. Olmstead, Melrose.	47.50
4823	Special Tobacco and Potato Manure.	G. B. Alderman, Suffield.	Manufacturer.	36.00
4848	Complete Manure for Corn and Grain.	Bradley Fertilizer Co., Boston, Mass.	C. H. Baker, Andover.	37.00
4836	Stockbridge Tobacco Manure.	Bowker Fertilizer Co., Boston, Mass.	J. E. Collins, Wapping.	50.00

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Analyses.

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$22.44*	† 6.4	....	....	....	....	....	5.90	6.46	.43	12.79	*12.0*	12.36	*11.0*	8.98	8.98	*10.0*
38.29	9.6	4.07	....	2.23	6.30	*5.5*	3.63	5.58	.47	9.68	*9.0*	9.21	....	8.91	8.91	*7.5*
41.34*	11.2	3.82	....	1.88	5.70	*5.5*	....	....	....	13.13	*12.0*	....	....	12.67	12.67	*12.5*
37.41	12.2	1.33	.14	3.70	5.17	*5.0*	2.05	5.54	3.10	10.69	*10.0*	7.59	....	.68	10.48	*10.0*
33.38*	12.3	.54	....	2.63	3.17	*2.5*	....	....	....	15.82	*13.0*	....	....	11.92	11.92	*10.0*
32.34*	12.8	....	....	....	3.06	*2.5*	....	....	...	16.25	*16.5*	....	....	11.82	11.82	*12.5*
33.67	12.8	1.55	....	2.36	3.91	*3.5*	4.38	5.19	.31	9.88	*9.0*	9.57	....	.79	9.77	*8.8*
40.72*	12.9	3.37	....	1.63	5.00	*5.5*	....	....	....	12.78	*12.0*	....	....	15.42	15.42	*12.5*
26.11*	14.8	....	.24	2.40	2.64	*2.5*	1.12	6.48	1.94	9.54	*7.5*	7.60	*6.5*	1.25	7.84	*6.0*
29.07	15.2	....	....	4.04	4.04	*3.0*	....	5.47	3.18	8.65	*8.0*	5.47	....	8.45	8.45	*7.0*
32.81	15.8	1.46	.16	3.60	5.22	*5.0*	1.87	5.76	2.81	10.44	*10.0*	7.63	*7.0*	.89	6.09	*5.0*
42.90*	16.5	7.44	....	1.53	8.97	*9.0*	....	....	....	8.62	*8.0*	....	....	8.45	8.45	*8.5*
31.95	18.9	.39	1.36	2.25	4.0	*3.3*	5.66	.94	.18	6.78	....	6.60	*5.8*	4.54	10.58	*10.0*
32.67	19.3	.39	1.74	2.33	4.46	*4.9*	4.45	1.76	.25	6.46	....	6.21	*4.5*	5.69	10.33	*9.0*
31.41	20.9	.41	.15	3.08	3.64	*3.0*	2.48	8.80	2.70	13.98	*10.0*	11.28	....	.81	5.56	*7.0*
32.95	21.3	....	2.66	1.80	4.46	*4.3*	4.59	1.30	.46	6.35	....	5.89	*4.0*	.76	9.68	*10.0*
32.79	21.0	....	.26	2.92	3.18	*4.9*	2.08	7.62	2.33	12.03	*10.0*	9.70	....	1.57	10.11	....
32.50	23.0	3.19	....	1.98	5.17	*5.0*	4.32	3.95	1.15	9.42	*6.0*	8.27	*4.0*	7.12	7.12	*6.0*
38.74	23.9	1.56	2.60	2.22	6.38	*6.2*	.27	4.53	1.01	5.81	*4.5*	4.80	....	.73	10.97	*10.5*
28.23	23.9	1.35	.64	1.15	3.14	*2.5*	6.09	6.66	.50	13.25	*12.0*	12.75	....	.67	3.12	*2.5*
30.41*	24.9	....	....	...	3.48	*3.0*	....	....	....	16.72	*17.0*	....	....	10.65	10.65	*12.5*
37.92	25.2	....	2.94	2.72	5.66	*5.8*	.59	3.46	.71	4.76	*6.0*	4.05	*5.0*	1.20	12.80	*10.0*
28.70	25.4	.63	....	2.55	3.18	*2.9*	2.02	4.89	.66	7.57	*6.0*	6.91	....	.26	9.88	*10.0*
29.46	25.5	1.32	....	2.0	3.32	*3.3*	3.79	7.99	2.61	14.39	*13.0*	11.78	*12.0*	5.02	5.02	*3.0*
39.78	25.6	3.16	....	2.92	6.08	*5.8*	1.06	4.92	6.75	12.73	*6.0*	5.98	....	.53	10.82	*10.0*

* See remarks on this analysis, page 49.

† Valuation exceeds cost.

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SPECIAL MANURES, SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4681	Grass and Grain Spring Top-Dressing.	Mapes' F. & P. G. Co., N. Y. City.	Geo. K. Nason, Willimantic.	$41.00
			Birdsey & Foster, Meriden.	40.00
			Mapes' Branch, Hartford.	39.00
4698	Corn Manure.	Mapes' F. & P. G. Co., N. Y. City.	D. B. Wilson, Waterbury.	41.00
			Geo. K. Nason, Willimantic,	41.00
			Quinnebaug Store, Danielsonville.	40.00
			Dean & Horton, Stamford.	40.00
				39.00
4650	Potato Manure.	Mapes' F. & P. G. Co., N. Y. City.	Geo. K. Nason, Willimantic.	43.00
			Quinnebaug Store, Danielsonville.	42.00
			Dean & Horton, Stamford.	42.00
			John H. Ray, Greenwich.	40.75
			Birdsey & Foster, Meriden.	42.00
			F. S. Bidwell, Windsor Locks	42.00
			Mapes' Branch, Hartford.	41.00
4695	Carteret Potato Manure.	Eastern Farm Supply Association, Montclair, N. J.	N. H. Sherwood, Southport.	32.00
				30.00
4808	Potato, Onion and Tobacco Manure.	Leander Wilcox, Mystic.	Browning & Gallup, New London.	36.00
			Mandy Gray, Poquetanuck.	34.00
				35.00
4700	Fruit and Vine Manure.	Mapes' F. & P. G. Co., N. Y. City.	Birdsey & Foster, Meriden.	39.00
			Mapes' Branch, Hartford.	38.00
4659	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston, Mass.	J. A. Lewis, Willimantic.	40.00
			L. F. Judson, Stratford.	38.00
4868	Potato Fertilizer.	Preston Fertilizer Co., Greenpoint, L. I.	E. N. Pierce & Co., Plainville.	39.00
			S. D. Keeler, Ridgefield.	38.00
4685	Potato, Hop and Tobacco Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	Henry Davis, Durham Center.	32.00
			D. N. Benton, Guilford.	34.00
				33.00
4788	High Grade Special for Potatoes and Tobacco.	Williams & Clark Fertilizer Co., N. Y. City.	W. B. Martin, Rockville.	39.00
			Hale, Day & Co., So. Manchester.	42.00
			John Bransfield, Portland.	40.00
			S. A. Flight. Highwood.	35.00
4719	Potato Manure, No. 1.	Lister's Agricultural Chemical Works, Newark, N. J.	A. N. Clark, Milford.	38.00
4677	Complete Corn Manure.	H. J. Baker & Bro., N. Y. City.	J. C. Lincoln, Berlin.	----
			E. White, Rockville.	40.00
4799	Stockbridge Manure for Corn.	Bowker Fertilizer Co., Boston, Mass.	Crawford & Devine, Uncasville.	40.00
			D. B. Wilson, Waterbury.	40.00
			Strong & Tanner, Winsted.	38.00
			J. C. Lincoln, Berlin.	40.00
			E. C. Dennis, Stafford.	40.00
			J. A. Paine, Danielsonville.	40.00
			J. A. Lewis, Willimantic.	40.00
4887	High Grade Tobacco Manure.	Bradley Fertilizer Co, Boston, Mass.	Bulkley & Hanmer, Wethersfield.	50.00
4998	Bradley's Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston, Mass.	Bulkley & Hanmer, Wethersfield.	39.00
			E. C. Dennis, Stafford.	40.00
			D. N. Clark, Shelton.	38.00

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ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$31.02	25.7	1.44	.98	2.52	4.94	*4.1*	3.70	4.19	.49	8.38	*7.0*	7.89	....	6.11	6.11	*5.0*
30.97	25.9	1.37	.40	2.07	3.84	*3.7*	5.86	5.03	.20	11.09	....	10.89	*8.0*	6.57	6.57	*6.0*
32.32	26.8	1.74	.44	1.67	3.85	*3.7*	5.41	4.46	.49	10.36	*8.0*	9.87	*8.0*	.72	8.06	*6.0*
23.48*	27.7	....	.18	2.69	2.87	*2.5*	1.30	7.90	.99	9.19	*7.5*	9.20	*6.5*	3.64	3.64	*6.0*
27.21*	28.6	.66	....	2.96	3.62	*3.3*	5.22	2.70	.65	8.57	*8.0*	7.92	*7.0*	2.00	5.97	*6.0*
29.34	29.5	.33	.26	1.57	2.16	*1.7*	4.08	3.82	.35	8.25	*7.0*	7.90	*5.0*	.60	12.44	*11.0*
29.30*	29.7	1.37	....	2.17	3.54	*3.7*	5.30	4.80	1.41	11.51	*9.0*	10.10	*8.0*	6.48	6.48	*6.0*
29.09	30.6	.72	....	2.54	3.26	*3.3*	4.80	4.73	2.69	12.22	....	9.53	*8.0*	2.80	6.60	*7.0*
25.15	31.2	....	....	2.74	2.74	*2.1*	7.71	2.27	1.69	11.67	*11.0*	9.98	*10.0*	4.09	4.09	*3.3*
29.57	31.8	1.30	.32	1.90	3.52	*3.7*	5.55	4.25	1.24	11.04	*8.0*	9.80	*7.0*	7.09	7.09	*7.0*
28.70	32.4	1.10	.44	2.16	3.70	*3.7*	6.72	1.42	1.01	9.15	....	8.14	*7.5*	7.36	7.36	*7.0*
30.03	33.2	.33	2.44	1.33	4.10	*4.9*	5.39	2.13	.35	7.87	....	7.52	*6.0*	7.41	7.41	*7.0*
29.84	34.0	1.50	....	2.23	3.73	*3.3*	8.21	3.05	.77	12.03	*10.0*	11.26	*8.0*	4.95	4.95	*4.0*
37.30†	34.0	....	2.66	2.88	5.54	*5.8*	1.01	2.63	1.92	5.56	*4.0*	3.64	....	.73	12.57	*10.8*
28.34†	34.1	1.36	....	2.46	3.82	*3.7*	4.66	3.63	2.23	10.52	*9.0*	8.29	*8.0*	6.30	6.30	*6.0*

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* See remarks on this analysis, page 49. † See remarks on this analysis, page 50.

SPECIAL MANURES, SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4660	Potato Special.	Crocker Fertilizer Co., Buffalo, N. Y.	Henry Davis, Durham Center.	$36.00
			Meeker Coal Co., Norwalk.	40.00
				38.00
4838	Fine Wrapper Tobacco Grower.	Williams & Clark Fertilizer Co., N. Y. City.	L. J. Grant, Wapping.	50.00
4839	Chittenden's Complete Fertilizer.	National Fertilizer Co., Bridgeport.	E. B. Clark & Sons, Milford.	38.00
			A. Y. Beach, Seymour.	40.00
			A. P. Wakeman, Fairfield.	38.00
			Manchester Elevator Co., Manchester.	41.00
				39.00
4795	Quinnipiac Onion Manure.	Quinnipiac Co., Boston, Mass.	F. S. Bidwell, Windsor Locks	40.00
4655	Stockbridge Manure for Potatoes and Vegetables.	Bowker Fertilizer Co., Boston, Mass.	W. B. Martin, Rockville.	40.00
			J. A. Lewis, Willimantic.	40.00
			W. Tillinghast, Plainfield.	30.00
			J. A. Paine, Danielsonville.	40.00
4724	Wheat and Corn Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	Henry Davis, Durham Center.	30.00
4817	Potato, Tobacco and Hop.	Pacific Guano Co., Boston, Mass.	Carlos Bradley & Son, Ellington.	33.00
4654	Vegetable, Vine and Tobacco Manure.	Great Eastern Fertilizer Co., Rutland, Vermont.	Wm. Burr & Son, Fairfield.	33.00
			E. T. Bates, Darien.	36.00
			Silas Finch, Greenwich.	32.00
4534	Swift Sure Potato Fertilizer.	M. L. Shoemaker & Co., Philadelphia, Pa.	F. Ellsworth, Hartford.	38.00
4683	High Grade Potato Manure.	E. Frank Coe Co., N. Y. City.	F. L. Hallock & Co., Birmingham.	38.00
			D. N. Benton, Guilford.	34.00
			J. O. Fox & Co., Putnam.	35.00
4723	Potato Manure.	Quinnipiac Co., Boston, Mass.	A. P. Wakeman, Fairfield.	34.00
			G. G. Tillinghast, Vernon.	33.00
			Meeker Coal Co., Norwalk.	36.00
			F. S. Bidwell, Windsor Locks	37.00
			F. M. Raymond, Westport.	35.00
4820	High Grade Potato Manure.	M. E. Wheeler & Co., Rutland, Vermont.	Wm. M. Owen, No. Haven.	33.00
			P. B. Moffitt, Pomfret.	34.00
			C. A. Loomis, Andover.	35.00
4819	Corn Fertilizer.	M. E. Wheeler & Co., Rutland, Vermont.	P. B. Moffitt, Pomfret.	32.00
			C. A. Loomis, Andover.	33.00
			Wm. M. Owen, No. Haven.	32.00
4682	Top-Dressing for Grass and Grain.	Bradley Fertilizer Co., Boston, Mass.	Raymond Bros., S. Norwalk.	37.00
4826	Cleveland Potato Phosphate.	Cleveland Dryer Co., Boston, Mass.	Chas. E. Scranton, Madison.	34.00
4741	Potato and Tobacco Fertilizer.	Clark's Cove Fertilizer Co., Boston, Mass.	John Dolbeare, Poquetanuck	32.00
			J. M. Burke, So. Manchester.	36.00
				35.00
4790	Americus Potato Phosphate.	Williams & Clark Fertilizer Co., N. Y. City.	John Bransfield, Portland.	35.00
			W. B. Martin, Rockville.	34.00
			Geo. Beaumont, Wallingford.	35.00
			Hale, Day & Co., So. Manchester.	36.00
			A. M. Clark, Scotland.	32.00
			D. B. Wilson, Waterbury.	36.00
			G. C. Greene, Torrington.	34.00
			S. A. Flight, Highwood.	33.00

ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
8.29	34.3	....	....	3.76	3.76	*3.7*	6.74	2.00	1.30	10.04	*9.0*	8.74	*8.0*	5.63	5.63	*5.4*
5.88	35.6	....	3.50	2.34	5.84	*5.8*	2.74	2.19	.93	5.86	....	4.93	*5.0*	.87	9.78	*10.0*
3.63	36.2	....	1.35	2.11	3.46	*3.7*	4.56	5.42	.68	10.66	*10.0*	9.98	*8.0*	5.52	5.52	*6.0*
0.17	37.1	1.30	....	2.44	3.74	*3.3*	5.18	2.85	1.90	9.93	*9.0*	8.03	*8.0*	7.89	7.89	*7.0*
0.07	37.5	1.58	....	1.81	3.39	*2.5*	6.77	3.08	.81	10.66	*8.0*	9.85	*6.0*	7.26	7.26	*5.0*
1.53	39.3	....	....	2.24	2.24	*2.1*	7.58	2.84	1.09	11.51	*11.0*	10.42	*10.0*	1.64	1.64	*1.6*
1.41	40.9	....	....	2.44	2.44	*2.1*	6.40	3.76	1.67	11.83	*9.0*	10.16	*8.0*	3.19	3.19	*3.0*
1.37	41.2	....	....	2.22	2.22	*2.1*	6.60	2.19	.57	9.36	*9.0*	8.79	*8.0*	6.09	6.09	*6.0*
1.75	42.0	.58	....	1.92	2.50	*2.5*	4.59	5.09	5.24	14.92	*11.0*	9.68	*8.0*	6.07	6.07	*6.0*
.41	43.3	....	.38	1.83	2.21	*1.9*	6.91	2.19	2.25	11.35	*9.0*	9.10	*8.0*	.41	5.16	*6.0*
.34	43.7	....	.59	2.17	2.76	*2.5*	3.65	4.10	1.78	9.53	*7.0*	7.75	*6.0*	4.51	5.79	*5.0*
.62	43.9	.10	....	2.30	2.40	*2.1*	6.78	1.93	.58	9.29	*9.0*	8.71	*8.0*	5.82	5.82	*5.8*
10	44.7	1.00	....	1.90	2.90	*1.7*	7.07	1.90	.65	9.62	*10.0*	8.97	*8.0*	2.22	2.22	*2.0*
07	47.5	4.96	....	....	4.96	*4.9*	1.62	4.36	1.04	7.02	*6.0*	5.98	*5.0*	.59	2.97	*2.5*
93	48.2	....	.14	2.18	2.32	*2.1*	6.84	3.22	1.43	11.49	*10.0*	10.06	*8.0*	3.22	3.22	*3.0*
84	48.8	....	....	2.28	2.28	*2.1*	6.03	4.12	1.58	11.73	*9.0*	10.15	*8.0*	3.24	3.24	*3.0*
43	49.3	.40	.13	2.31	2.84	*2.5*	3.44	3.97	1.55	8.96	*7.0*	7.41	*6.0*	5.57	5.57	*5.0*

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SPECIAL MANURES, SAMPLED BY THE STATION.—*Continued.*

Station No.	Name or Brand.	Manufacturer.	Dealer.	Dealer's Cash Price per Ton.
4801	Vegetable, Vine and Fruit Manure.	Read Fertilizer Co., N. Y. City.	R. W. Keeler, Ridgefield.	$36.00
			Wm. M. Bulkley, Fairfield.	33.00
				34.50
4814	Potato Fertilizer.	Cumberland Bone Phosphate Co., Boston, Mass.	W. F. Palmer, Scotland.	34.00
4818	General for Grass and Grain.	Great Eastern Fertilizer Co., Rutland, Vermont.	J. A. Foster, Stafford.	34.00
4755	Wheat and Corn Producer.	Niagara Fertilizer Co., Buffalo, N. Y.	Wm. H. Loomis, Bolton.	30.00
				29.00
			Wm. Higgins, New London.	28.75
4688	Potato Special, Welcome Brand.	Walker, Stratman & Co., Pittsburgh, Pa.	E. White, Rockville.	33.00
4831	Grass Fertilizer.	Quinnipiac Co., Boston, Mass.	O. S. Olmstead, Melrose.	35.00
4751	Corn Manure.	Quinnipiac Co., Boston, Mass.	Ansel A. Champion, Black Hall.	34.00
4833	Potato Manure.	Bradley Fertilizer Co., Boston, Mass.	W. B. Martin, Rockville.	36.00
			J. A. Lewis, Willimantic.	37.00
			Quinnebaug Store, Danielsonville.	38.00
			G. W. Carver & Son, Putnam	34.00
			Raymond Bros. So. Norwalk	36.00
			R. A. Parker, Warehouse Point.	38.00
			L. F. Judson, Stratford.	37.00
4753	Grass and Grain Grower.	Niagara Fertilizer Works, Buffalo, N. Y.	Wm. Higgins, New London.	26.00
			Wm. H. Loomis, Bolton.	28.00
				27.00
4844	Grass Manure.	Williams & Clark Fertilizer Co., N. Y. City.	L. J. Grant, Wapping.	36.00
4792	Special Potato Manure.	Pacific Guano Co., Boston, Mass.	S. R. Jones, Deep River.	38.00
			T. B. Wickwire, Berlin.	38.00
			R. F. Woodford, Plainville.	35.00
			P. F. Walsh, Montville.	36.00
				37.00
4832	Bay State Potato Manure.	Clark's Cove Fertilizer Co., Boston, Mass.	White & Juno, Rockville.	33.00
4697	Special Potato Fertilizer.	Lister's Agricultural Chemical Works, Newark, N. J.	J. A. Foster, Stafford.	32.00
			E. F. Hutchinson, Andover.	34.00
				33.00
4803	Potato and Tobacco Fertilizer.	Standard Fertilizer Co., Boston, Mass.	Arnold Warner, So. Coventry.	33.00
4841	Chicopee A 1, Vegetables and Potatoes.	Chicopee Guano Co., N. Y. City.	Jno. Ahern, Windsor Locks.	40.00
4752	Potato, Tobacco and Hop Fertilizer.	Niagara Fertilizer Works, Buffalo, N. Y.	Wm. H. Loomis, Bolton.	33.00
			Wm. Higgins, New London.	32.00
4833	Big Bonanza, Tobacco Special.	Walker, Stratman & Co., Pittsburgh, Pa.	J. T. Ball, Unionville.	36.00
4874	Grass and Oats Fertilizer.	M. E. Wheeler & Co., Rutland, Vermont.	Wm. M. Owen, No. Haven.	28.00
4869	Lawn and Grass.	Mason, Chapin & Co., Providence, R. I.	Cadwell & Jones, Hartford.	50.00
4870	"Potato."	Mason, Chapin & Co., Providence, R. I.	Cadwell & Jones, Hartford.	50.00
4868	Corn Fertilizer.	Mason, Chapin & Co., Providence, R. I.	Geo. K. Nason, Willimantic.	50.00

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ANALYSES.—*Continued.*

Valuation per Ton.	Percentage Diff. between Cost and Valuation.	Nitrogen.					Phosphoric Acid.							Potash.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
$22.87	50.9	....	....	1.94	1.94	*1.7*	5.34	2.03	.43	7.70	*7.0*	7.37	*6.0*	8.51	8.51	*8.0*
22.52	50.9	....	....	2.16	2.16	*2.0*	6.08	4.23	1.17	11.48	*11.0*	10.31	*9.0*	3.30	3.30	*3.0*
22.49	51.1	....	....	2.93	2.93	*2.9*	7.12	1.89	.42	9.43	*9.0*	9.01	*8.0*	2.26	2.26	*2.0*
19.18	51.1	....	....	1.60	1.60	*1.2*	6.37	2.78	2.10	11.25	*9.0*	9.15	*8.0*	2.62	2.62	*2.2*
25.00	52.0	....	....	2.20	2.20	*1.7*	7.82	2.80	.47	11.09	*13.0*	10.62	*9.0*	....	4.85	*5.0*
22.85	53.1	4.30	....	....	4.30	*3.9*	2.53	2.90	1.09	6.52	*6.0*	5.43	*5.0*	.76	3.24	*2.0*
21.57	57.6	....	.14	2.30	2.44	*2.1*	5.44	3.96	1.82	11.22	*10.0*	9.40	*9.0*	2.04	2.04	*1.5*
22.79	57.9	.51	....	2.24	2.75	*2.5*	4.22	3.06	1.13	8.41	*8.0*	7.28	*6.0*	5.54	5.54	*5.0*
16.83	60.4	....	....	.97	.97	*0.8*	4.75	5.13	2.75	12.63	*8.0*	9.88	*7.0*	1.32	1.32	*1.1*
22.27	61.6	4.12	....	....	4.12	*3.9*	2.62	2.58	1.09	6.29	*6.0*	5.20	*5.0*	.53	3.40	*2.0*
22.55	64.0	.26	.17	2.25	2.68	*2.5*	3.36	3.92	1.89	9.17	*7.0*	7.28	*5.0*	5.12	5.12	*5.0*
23.02	65.0	.26	....	2.41	2.67	*2.5*	4.32	3.89	1.12	9.33	*7.0*	8.21	*6.0*	4.87	4.87	*5.0*
19.83	66.4	....	.24	1.52	1.76	*1.7*	6.19	2.54	2.31	11.04	*8.0*	8.73	....	3.09	3.09	*3.0*
22.17	71.4	....	....	2.30	2.30	*2.3*	7.17	2.29	.80	10.26	*10.0*	9.46	*9.0*	3.49	3.49	*3.0*
23.22	72.2	....	....	2.46	2.46	*2.9*	7.33	1.73	1.20	10.26	*8.0*	9.06	*7.0*	4.35	4.35	*5.0*
17.95*	78.3	....	....	.54	.54	*1.6*	7.52	2.78	1.29	11.59	*9.0*	10.30	*8.0*	3.97	3.97	*2.7*
19.88	81.0	....	....	1.88	1.88	*1.7*	5.24	3.78	2.07	11.09	*15.0*	9.02	*11.0*	2.67	2.67	*2.0*
12.84*	118.0	....	....	....	....	....	4.20	5.16	1.35	11.71	*12.0*	9.36	*10.0*	1.75	1.75	*2.0*
19.62	154.8	4.28	....	....	4.28	*5.4*	.25	2.93	7.12	10.30	*5.0*	3.18	....	.45	.45	*1.0*
17.17	181.3	3.88	....	....	3.88	*3.3*	.43	1.43	9.81	11.67	*10.0*	1.86	....	.13	.13	*1.0*
15.70	218.4	2.50	....	....	2.50	*3.0*	....	1.62	12.45	14.07	*11.0*	1.62	....	1.60	1.60	*2.8*

* See remarks on this analysis, page 50.

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ANALYSES.

	4886	4888	4885	4914	4690	4610	4611	4619	4620
Nitrogen as Nitrates...	trace	trace	....	....	.19	4.03	7.54	1.27	1.51
as Ammonia..	....	....	....	....	....	....	....	.12	.16
Organic.....	5.26	3.90	2.20	....	2.25	2.09	1.48	3.81	3.49
Total.....	*5.26*	*3.90*	*2.20*	none	*2.44*	*6.12*	*9.02*	*5.20*	*5.16*
Guaranteed...	5.7	....	1.7	none	2.0	5.5	8.8	5.0	5.0
Phosphoric acid, soluble.	5.57	4.22	8.40	4.77	4.88	....	....	1.46	1.82
reverted.....	1.02	4.59	3.18	5.73	3.96	....	....	8.10	7.60
insoluble	.25	3.98	1.03	2.49	1.16	....	....	.98	.90
Total	*6.84*	*12.79*	*12.61*	*12.99*	*10.00*	*12.52*	*8.69*	*10.54*	*10.32*
Guaranteed...	6.0	....	....	12.0	11.0	12.0	7.9	10.0	10.0
Potash as Muriate	.67	1.01	3.84	2.42	4.49	12.49	8.99	.78	1.03
as Sulphate	10.55	3.59	....	....	....	....	....	9.88	5.03
Total	*11.22*	*4.60*	*3.84*	*2.42*	*4.49*	*12.49*	*8.99*	*10.66*	*6.06*
Guaranteed...	10.0	....	4.0	2.0	3.0	13.0	8.4	10.0	5.0
Cost per ton.....	....	....	....	....	$32.00	46.00	50.00	42.00	38.00
Valuation per ton.....	$36.94	29.25	24.71	15.20	22.72	42.08	43.70	38.94	33.75

MISCELLANEOUS FERTILIZERS AND MANURES.

COTTON HULL ASHES.

In the table on page 61 are given 23 analyses of these ashes. Samples **4916** and **4917** were drawn from the same car lot, the former from sacks containing ashes of a reddish color, the latter from sacks in which the ashes were light gray.

Allowing 6, 5½ and 2 cents per pound respectively for soluble, reverted, and insoluble phosphoric acid, the price of actual potash in twenty samples of cotton hull ashes has ranged from 4.3 cents to 13 cents per pound, the average being 6.1 cents.

The ashes sold in 1895 have been of better average quality than those sold in the previous year.

"UNLEACHED WOOD ASHES."

In the table page 62 are given 16 analyses of this article. The per cent. of soluble potash ranges from 1.52 per cent. to 7.40, being on the average 4.34 per cent., while the average content of phosphoric acid was 1.55.

These ashes contain on the average between 45 and 50 per cent. of carbonate of lime, and some 14 per cent. of coal, sand and earth.

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Analyses of Cotton Hull Ashes.

Station No.	Dealer or Purchaser.	Sampled by	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Potash Soluble in Water.	Cost per ton.	Valuation per ton.	Potash costs per pound in cents.
4624	G. A. Douglass, Thompsonville	E. M. Barnes, Thompsonville	2.43	7.40	.48	26.14	$33.75	$38.70	4.3
4525	I. L. Spencer, Suffield	F. B. Hathaway, Windsor Locks	3.41	8.98	1.30	28.35	40.00	44.25	4.5
4477	Planters Cotton Seed and Crushing Association, Greenville, Tenn	T. Soule & Co, New Milford	.50	5.09	1.11	24.64	30.00	32.51	4.7
4916	W. F. Andross, East Hartford	Edmund Halliday, Suffield	1.30	5.52	.60	27.80	36.00	37.06	5.1
4588	Olds & Whipple, Hartford	Olin Wheeler, Buckland	1.28	3.24	.57	37.41	45.00	44.61	5.3
4526	I. L. Spencer, Suffield	E. S. Seymour, Windsor Locks	2.71	9.39	1.42	24.35	40.00	39.71	5.3
4640	Olds & Whipple, Hartford	Station Agent	3.26	7.00	.20	30.61	45.00	43.83	5.4
4561	G. A. Douglass, Thompsonville	C. D. Woodworth, Thompsonville	.80	7.82	.53	22.17	33.75	33.05	5.4
4734	W. W. Cooper, Suffield	Alfred Griffin, Granby	1.50	8.79	.66	25.40	40.00	38.40	5.5
4568	L. Sanderson, New Haven	Chas. H. Wells, Suffield	.91	8.21	.41	27.16	40.00	38.80	5.5
4500	W. W. Cooper, Suffield	G. A. Harmon, Suffield	1.42	9.69	.44	24.89	40.00	38.68	5.5
4584	Olds & Whipple, Hartford	Wm. S. Pinney, Suffield	.99	10.08	.44	24.44	40.00	38.12	5.6
4571	J. C. Eddy, Simsbury	David L. Brockett, Suffield	.77	8.00	.44	26.35	40.00	37.57	5.7
4917	W. F. Andross, East Hartford	Edmund Halliday, Suffield	1.33	7.60	.78	21.37	36.00	32.71	6.0
4476	F. W. Brode & Co., Memphis, Tenn.	T. Soule & Co., New Milford	.45	5.44	2.17	17.24	30.00	25.49	6.5
4572	Edmund Halliday, Suffield	David L. Brockett, Suffield	1.01	6.53	.55	20.12	35.00	29.74	6.5
4663	R. A. Parker, Warehouse Point	John E. Thompson, Warehouse Point	2.03	6.53	.59	21.92	40.00	32.88	6.8
4615	R. A. Parker, Warehouse Point	Joseph Watson, Enfield	1.97	6.58	1.03	20.37	40.00	31.40	7.3
4768	Troknee Mills, Spartanburg, S. C.	E. A. Wildman, New Milford	.74	5.04	.45	17.07	35.00	24.53	8.3
5001	Olds & Whipple, Hartford	Olin Wheeler, Buckland	....	4.48	1.11	15 24	45.00	21.37	13.0
4539	Southern Mills	Edward Austin, Suffield	.58	9.44	.93	26.92	....	39.72	....
4540	Southern Mills	Edward Austin, Suffield	....	....	....	27.89	....	....	....
4674	Eli Hough, for Tobacco Exp't. Co.	Station Agent	....	....	....	24.11	....	....	....

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Analyses of "Unleached Wood Ashes."

Station No.	Dealer.	Sampled and sent by	Phosphoric Acid.	Potash Soluble in Water.	Lime.	Carbonic Acid.	Sand and Earth.	Coal.	Cost per ton.
4475	Allison & Frost, New York City	J. E. Larmer, Jr., Norwalk	1.80	5.59	33.90	23.07	12.13	2.28	$10.50
4995	Allison & Frost, New York City	L. S. Ellsworth, Simsbury	1.15	5.09	33.20	20.01	6.43	1.50	10.50
4515	Forest City Wood Ash Co., Boston	T. J. Stroud, Shaker Station	1.68	3.95	24.11	14.81	17.33	2.96	10.50
4900	Forest City Wood Ash Co., Boston	Ard Welton, Plymouth	.64	1.52	30.46	19.29	24.62*	....	10.50
4523	A. L. Hartness, Detroit	N. S. Platt, Cheshire	2.28	7.40	30.35	18.15	10.44	1.40	10.00
4465	Monroe, Lalor & Co., Oswego, N. Y.	D. N. Clark, Westville	1.78	4.45	35.12	23.78	8.17	2.11	11.50
4485	Monroe, Lalor & Co., Oswego, N. Y.	J. N. Barnes, Yalesville	1.43	3.40	38.75	21.08	8.89	1.46	11.00
4538	Monroe, Lalor & Co, Oswego, N. Y.	Edward Austin, Suffield	1.84	4.27	42.15	22.86	3.93	1.46	11.00
4626	Monroe, Lalor & Co, Oswego, N. Y.	W. F. Whitney, Yalesville	1.25	4.88	36.45	20.65	7.73	2.52	10.00
4766	Monroe, Lalor & Co., Oswego, N. Y.	T. S. Gold, West Cornwall	1.15	3.40	38.77	22.96	5.03	1.43	11.50
4925	Monroe, Lalor & Co., Oswego, N. Y.	S. D. Woodruff & Sons, Orange	1.41	3.57	36.15	20 65	8.50	1.88	11.00
4999	Monroe, Lalor & Co., Oswego, N. Y.	D. N. Clark, Westville	.70	3.78	36.33	24.21	15.11	1.77	....
5000	Monroe, Lalor & Co., Oswego, N. Y.	D. N. Clark, Westville	1.25	4.07	27.89	19.58	26.88	2.17	....
4590	J. W. Waller, Long Hill	L. N. Mallett, Long Hill	1.71	5.31	30.58	18.16	10.11	1.21	11.00
4644	Seymour Brass Co., Seymour	M. L. Coleman, Ansonia	2.25	4.52	42.38	23.85	4.34	.74	....
4673		Conn. Tobacco Exp't. Co., Poquonock	2.43	4.28	29.25	14.95	26.11	4.32	....

* Includes charcoal.

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The same fertilizing ingredients can be bought vastly cheaper in other forms.

One ton of cotton hull ashes, for instance, costing $40.00, will supply as much potash and phosphoric acid as six tons of these wood ashes, costing $63.00. The six tons of wood ashes, however, carry 3,260 pounds of lime in excess of the lime in a ton of cotton hull ashes.

Under some conditions, no doubt, this lime is worth more on the soil than the potash and phosphoric acid themselves, and cannot, perhaps, be purchased to better advantage than in the form of wood ashes. In many other cases the cotton hull ashes contain all the alkali that the soil requires.

Home Mixtures.

The fact that cotton seed meal and dissolved phosphate rock sold at very low prices during the last winter and spring, induced many farmers to mix their own fertilizers who had not previously done it.

Fifteen samples of these home mixtures have been analyzed at this Station. In the following tables are given the formulas by which they were compounded and their chemical analyses and valuations. These fertilizers as a rule have a higher percentage of nitrogen and of potash than the average of factory-mixed goods and considerably less phosphoric acid.

The *valuations* are calculated on the same basis as in factory-mixed goods.

The *cost* covers the materials alone *at regular market rates unless otherwise stated*, and does not include cost of mixing. Perhaps from one dollar to one and a half dollars per ton should be allowed for this.

The *mechanical condition* of these home-mixtures has been uniformly good, and not noticeably different from that of factory-mixed goods.

Considerable objection has been made to home-mixing according to such formulas as are given in the table, on the following grounds:

1st. That mixtures made with dissolved rock phosphate would cake or set in the bags, making their application to land difficult.

2d. That the soluble and reverted phosphoric acid of dissolved rock phosphate was not so available to crops as that of dissolved bone black.

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3d. That the nitrogen of cotton seed meal was not so available to crops as that of animal matter.

4th. That cotton seed meal would not run through a fertilizer drilling machine.

5th. That no money could be saved by home-mixing.

As has been repeatedly stated in previous reports of this Station, there is no evidence nor any reason to suppose that the soluble and reverted phosphoric acid of dissolved rock is any less available than that of dissolved bone black. It is certain that most factory-mixed goods are made with the former rather than the latter.

Careful experiments indicate that the nitrogen of cotton seed meal is as readily available as the best forms of animal matter, and decidedly more available than that of fish or tankage. When the nitrogen of blood or of tankage costs fifteen cents a pound, and that of cotton seed meal only twelve cents, it is a waste of money to use the former instead of the latter.

The other objections against these formulas may best be met by the statements of those who have had some years' experience in mixing their own fertilizers in this State.

"Mixtures of nitrate of soda, muriate of potash and dissolved rock soon grow hard by standing, but by using, say two hundred pounds or more of dry material, as tankage or bone, I have no trouble. I have used no factory-mixed goods in years, for I save eight to ten dollars per ton over agent's prices by mixing my own."

"The mixture of acid phosphate, nitrate of soda and muriate of potash would not go through the fertilizer attachment of an Aspenwall Potato Planter. It seemed to work right up into a paste by the agitator. With the addition of 400 pounds of cotton seed meal to the ton it went through all right, though not as well as when 400 pounds of dry, rather coarse raw bone were added to the ton, in place of cotton seed meal. Home mixtures have certainly given good satisfaction and it has paid me to make my own mixtures."

"I have never had any trouble on account of caking even if kept over until the next season. This year a mixture containing 600 pounds of (dissolved) South Carolina rock per ton, mixed about May 1st, was in good condition when the last was used, July 10th. I did not use a drill, but cotton seed meal gave no trouble in a hand distributor or 'Eclipse' Corn Planter. I most decidedly think it has paid me to do my own mixing. It is some

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Formulas and Analyses of Home Mixtures.

Station No.	Made by	Formula, pounds per ton of mixture.								Analyses.								Cost (unmixed) and Valuation.	
		Nitrate of Soda.	Cotton Seed Meal.	Tankage.	Bone.	Dissolved Bone Black.	Dissolved Rock Phosphate.	Sulphate of Potash.	Muriate of Potash.	Nitrogen as Nitrates.	Organic Nitrogen.	Total Nitrogen.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash.	Cost per ton.	Valuation per ton.
4527	S. D. Woodruff & Sons, Orange	----	1150	----	----	----	600	----	250	----	4.28	4.28	3.09	3.07	1.12	7.28	7.15	$19.28*	$29.82
4860	S. D. Woodruff & Sons, Orange	----	1150	----	----	----	600	----	250	----	4.08	4.08	3.57	3.54	.48	7.59	6.36	19.28*	27.54
4649	J. H. Webb, Hamden	----	1200	----	----	----	500	----	300	----	4.27	4.27	2.67	2.22	.14	5.03	7.99	22.50	26.98
4850	Clifton Peck, Lebanon	400	----	600	----	1000	----	----	----	2.97	2.03	5.00	9.82	2.42	.83	13.07	.49	33.90	30.85
4851	Dennis Fenn, Milford	200	----	800	400	400	----	----	200	1.31	3.35	4.66	3.82	4.79	3.93	12.54	4.78	34.25	30.70
4852	G. H. Bartlett, North Guilford	200	400	700	----	300	----	----	400	1.59	3.77	5.36	2.70	3.28	1.73	7.71	10.42	30.15	34.13
4853	Andrew Ure, New Haven	----	800	----	----	----	800	----	400	----	2.93	2.93	5.04	3.15	.19	8.38	7.04	22.50	25.61
4854	M. D. Beach, Litchfield	320	260	260	----	----	680	----	480	2.62	1.96	4.58	2.58	3.59	1.07	7.24	10.79	30.19	31.52
4855	J. P. Phelps, Hamden	600	----	----	----	----	1100	----	300	4.64	----	4.64	5.97	1.42	.08	7.47	9.34	29.00	31.08
4856	R. H. Tucker, Saybrook	----	----	600	1080	----	----	----	320	----	4.34	4.34	----	----	----	14.58	8.10	31.10†	28.66
4857	G. F. Platt & Son, Milford	200	----	700	300	700	----	----	100	1.40	3.74	5.14	4.10	4.00	2.26	10.36	2.39	36.25	28.91
4858	G F. Platt & Son, Milford	200	----	700	300	700	----	----	100	1.52	3.28	4.80	2.53	5.60	3.38	11.51	3.45	36.25	29.04
4876	W. H. Olcott, South Manchester	----	1200	----	----	----	500	----	300	----	4.08	4.08	2.16	3.16	.69	6.01	8 18	----	27.17
4877	W. H. Olcott, South Manchester	----	1200	----	----	----	500	500	----	----	4.14	4.14	2.03	3.16	.72	5.91	7.97	----	28.24
4920	J. H. Webb, Hamden	----	----	----	1800	----	----	----	200	----	3.70	3.70	----	----	----	21.73	3.86	34.00	33.39

* Car lot quantities. † Special rates on bone and tankage.

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trouble, but the actual cost has never exceeded $1.25 per ton and has averaged less than $1.00."

"I had no trouble from caking of the acid phosphate used. I had no trouble in using the mixture in any way. The cotton seed fertilizer has given me as good satisfaction as any factory-mixed I ever used. It has paid me extremely well to make home-mixtures."

"When used soon after mixing we had no trouble from caking. A small lot after standing two months was somewhat caked. I applied the cotton seed mixture at the same rate per acre as I commonly apply the factory-mixed. The crops seem as good and there was a saving of about $15.00 per ton in favor of home-mixture."

"There was no trouble whatever from caking. We never handled a fertilizer which worked better, all the constituents being fine-ground and smooth. We tested the mixture by the side of two well known high grade brands of fertilizer, and the result showed that the mixture was fully as effective as the factory-mixed goods. The only way in which the factory goods worked better in our trials was that the crops started a little quicker. The home-mixture was a little slow in starting.

We consider this due to the fact that we used no nitrate of soda. This is one of the things we think we have learned by our experience.

We think the home-mixture has paid us as well as any experiment we ever tried. We shall mix all our own fertilizers in the future."

Swamp Muck.

4585. From J. P. Newton, Saybrook. Dug in the fall and sample taken from heap which had been exposed through the winter.

4637. "Pond muck." Dried under cover. From Samuel Wilson, Wolcott.

4646. Swamp muck, partially dried. From Miss M. A. Neale, Southington.

4667. Pond muck and aquatic weeds taken from the pond in the fall and let lie over winter in heaps. From Frank B. Ashton, Middletown.

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ANALYSES.

As received.

	4585	4687	4646	4667
Water	67.43	4.68	39.90	55.82
Organic matter	18.50	17.40	33.89	12.27
Ash	14.07	77.92	26.21	31.91
	100.00	100.00	100.00	100.00
Sand and soil	12.83	73.20	19.03	25.92
Nitrogen	.44	.60	1.24	.75

Water-free.

Organic matter	56.80	18.27	56.30	27.85
Ash	43.20	81.73	43.70	72.15
	100.00	100.00	100.00	100.00
Sand and soil	39.39	76.86	31.58	58.83
Nitrogen	1.35	.63	2.06	1.70

These samples show the usual variations in quality. From one-third to three-fourths of the weight of the dry material consists of sand and soil, but there is a considerable quantity of nitrogen in three of the samples, probably of some value as a fertilizer though the nitrogen of swamp muck is usually rather inert.

MARINE MUD.

This material is much used as a fertilizer and amendment on shore farms, and is believed in some cases to be equal in value to stable manure, load for load.

Its quality as a fertilizer is found to vary with the locality from which it is taken, and these differences in fertilizing value are not indicated or explained by chemical analysis.

4482. Taken from the surface to depth of one foot.

4484. Taken from 12 to 24 inches below the surface.

4483. Taken from 24 to 36 inches below the surface.

All of the above were taken by C. Q. Eldridge, Old Mystic, from a mud flat in the Mystic River.

4919. Mud deposited by a small river. Sent by D. C. Spencer, Saybrook.

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ANALYSES.

As received.

	4482	4484	4488	4919
Water	27.33	37.78	46.14	30.18
Organic matter	3.18	3.42	4.40	7.18
Ash	69.49	58.80	49.46	62.64
	100.00	100.00	100.00	100.00
Sand and soil	67.01	55.42	45.10	55.53
Nitrogen	.08	.11	.13	.25
Phosphoric acid	.05	.04	.05	....

Water-free.

Organic matter	4.36	5.47	8.36	10.27
Ash	95.64	94.53	91.64	89.73
	100.00	100.00	100.00	100.00
Sand and soil	91.80	88.67	85.69	79.40
Nitrogen	.11	.18	.24	.36
Phosphoric acid	.07	.06	.10	....

BEEF SCRAPS.

4648. A sample of this material was sent by F. J. Hamilton, Thompsonville. It consists of waste gathered from meat markets, steamed or boiled to extract the grease and pressed into large cakes after removing the larger bones. It is used chiefly as a poultry food, but was sent to the Station to determine its fertilizer value.

The sample contained

Moisture	23.17
Nitrogen	7.22
Phosphoric acid	3.78

It contains, even in its damp state, as much nitrogen and more phosphoric acid than cotton seed meal. But owing to its mechanical condition it would be difficult to use it directly as a fertilizer. It should be composted with other material.

ANTHRACITE COAL ASHES.

4524. A sample of the finest part of coal ashes deposited in the ash box and flues of boilers in a large steam-heating plant. Sampled and sent by J. F. Barnard, North Haven.

It contained 83.56 per cent. of matters insoluble in strong acid, 3.16 per cent. of phosphoric acid and .12 per cent. of potash.

While its value as a fertilizer must be very small, it is quite possible that a heavy application of this material might greatly improve a very light, sandy soil.

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REVIEW OF THE FERTILIZER MARKET.

FOR THE YEAR ENDING NOVEMBER 1ST, 1895.

BY E. H. JENKINS.

NITROGEN.

Nitric Nitrogen.

The *wholesale* New York quotation of nitrogen in this form was 13.2 cents in November, 1894. It fell steadily to 10.8 cents in April and since then has risen gradually to 11.7 cents in October, 1895.

The average of the monthly quotations (given on page 74) shows that nitrate of soda has ruled lower this year than for some years previously. The figures are as follows:

Year	1895	1894	1893	1892	1891	1890
Average quotation	11.4	13.0	12.7	12.1	12.9	11.5

The *retail* price of nitrogen in nitrate in this State at freight centers has been about 15½ cents per pound.

Ammonic Nitrogen.

The *wholesale* New York quotations of nitrogen in the form of sulphate of ammonia have been very much lower than in 1894, when they were practically prohibitory on its use as a fertilizer. The monthly quotation in November 1894 was 16.4 cents per pound. It fell to 15 cents in January, held that figure till April and has fallen steadily ever since, being quoted in October, 1895, at 12.2.

The average of the year's monthly quotations has been 14.3.

The corresponding averages for the years 1894, 1893, 1892, 1891 and 1890, were respectively 17.3, 15.7, 14.5, 15.6, and 16 cents, so that sulphate of ammonia has ruled lower this year than in any year since 1889.

Sulphate of ammonia has not figured in the Connecticut retail market.

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Organic nitrogen.

The *wholesale* New York quotations of nitrogen in the forms of red blood, black or low grade blood and concentrated tankage for each month in the year are shown in the table on page 74. Azotin has not been quoted since February.

It will be seen that nitrogen in all these forms of animal matter has been cheaper than in the years 1893 and 1894, and that both high grade and low grade blood have steadily declined in price since January.

But these forms of organic nitrogen do not often appear in our retail market.

Low grade tankage, fish, bone, and cotton seed meal are the forms most used by those who depend on home-mixing or the use of fertilizer chemicals rather than on factory mixtures.

Phosphatic Materials.

Rough bone and ground bone have been quoted uniformly at $19.50 and $22.75 per ton, wholesale, through the whole year.

Ground Charleston rock has also been quoted at $8.12½ per ton till September and since then at much lower rates.

Sulphuric acid quotations have remained unchanged through the year.

Available phosphoric acid in dissolved rock phosphate has been quoted during the season at prices ranging from 2.62 to 3.5 cents per pound *wholesale.*

Dissolved phosphate rock has during the past year figured somewhat in our retail market, and there will no doubt be a further demand for it the coming season. For analyses and further remarks on the subject, see pages 25 and 64.

Potash.

Muriate of Potash.

Since January potash in this form has been quoted *at wholesale* from 3.54 to 3.60 cents per pound, half a cent lower than during the last six months of 1894.

The retail price in Connecticut has ranged from 4 to 4½ cents per pound.

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The Double Sulphate of Potash and Magnesia.

Since January, 1895, this has been quoted, *at wholesale*, at 4.32 cents per pound, somewhat lower than last year.

It has cost at retail in Connecticut about 5.3 cents per pound.

High Grade Sulphate of Potash.

The *wholesale* New York quotation of potash in this form has been about 4.2 cents for the year, more than half a cent per pound lower than in 1894.

It has retailed in this State at prices ranging from 4.9 to 5.8 cents per pound.

The review of the market quotations indicates in general that nitrogen in all forms has ruled considerably lower this year than last, that potash salts have been somewhat cheaper, and that there has been no great change in the cost of available phosphoric acid.

The market quotations given above are taken from the "Oil, Paint and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage and some other articles are quoted and sold by the ton. The seller usually has an analysis of his stock and purchasers often control this by analysis at the time of purchase.

Sulphate of ammonia, nitrate of soda and muriate of potash are quoted and sold by the pound, and generally their wholesale and retail rates do not differ very widely.

Blood, azotin and ammonite are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the percentage of ammonia by 14 and divide that product by 17). A "unit of ammonia" is one per cent., or 20 pounds per ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain $8\frac{1}{2}$ units of ammonia, and if quoted at $2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.35 =$ $19.13.

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The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given :

Ammonia at	$3.00	per unit	is equivalent to	Nitrogen at	18.2	cts. per lb.
"	2.90	"	"	"	17.6	"
"	2.80	"	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"	"	"	15.8	"
"	2.50	"	"	"	15.2	"
"	2.40	"	"	"	14.6	"
"	2.30	"	"	"	14.0	"
"	2.20	"	"	"	13.4	"
"	2.10	"	"	"	12.8	"
"	2.00	"	"	"	12.2	"
"	1.90	"	"	"	11.6	"
"	1.80	"	"	"	11.0	"

Commercial sulphate of ammonia contains on an average 20.5 per cent. of nitrogen, though it varies considerably in quality. With that per cent. of nitrogen (equivalent to 24.3 per cent. of ammonia),

At	4.00	cents per pound,	Nitrogen costs		19.5	cents per lb.
"	3.95	"	"		19.3	"
"	3.90	"	"		19.0	"
"	3.85	"	"		18.8	"
"	3.80	"	"		18.5	"
"	3.75	"	"		18.3	"
"	3.70	"	"		18.0	"
"	3.65	"	"		17.8	"
"	3.60	"	"		17.5	"
"	3.55	"	"		17.3	"
"	3.50	"	"		17.1	"
"	3.45	"	"		16.8	"
"	3.40	"	"		16.6	"

Commercial Nitrate of Soda averages 95 per cent. of pure sodium nitrate or 16.0 per cent. of nitrogen.

If quoted at	3.0	cents per pound,	Nitrogen costs		18.8	cents per lb.
"	2.9	"	"		18.2	"
"	2.8	"	"		17.5	"
"	2.7	"	"		16.9	"
"	2.6	"	"		16.2	"

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If quoted at	2.5	cents per pound,	Nitrogen costs	15.6	cents per lb.
"	2.4	"	"	15.0	"
"	2.3	"	"	14.4	"
"	2.2	"	"	13.8	"
"	2.1	"	"	13.2	"
"	2.0	"	"	12.5	"
"	1.9	"	"	11.9	"
"	1.8	"	"	11.3	"
"	1.7	"	"	10.6	"

Commercial Muriate of Potash and also High Grade (98 per cent.) Sulphate of Potash usually contain 50½ per cent. of "actual potash," or potassium oxide.

If quoted at	2.60	cents per lb.,	Potassium Oxide costs	5.15	cents per lb.
"	2.50	"	"	4.95	"
"	2.40	"	"	4.75	"
"	2.30	"	"	4.55	"
"	2.25	"	"	4.45	"
"	2.20	"	"	4.35	"
"	2.15	"	"	4.25	"
"	2.10	"	"	4.15	"
"	2.05	"	"	4.06	"
"	2.00	"	"	3.96	"
"	1.95	"	"	3.86	"
"	1.90	"	"	3.76	"
"	1.85	"	"	3.66	"
"	1.80	"	"	3.56	"
"	1.75	"	"	3.46	"
"	1.70	"	"	3.36	"

The Double Sulphate of Potash and Magnesia has about 26½ per cent. of potassium oxide.

If quoted at	1.00	cents per lb.,	Potassium Oxide costs	3.77	cents per lb.
"	1.05	"	"	3.96	"
"	1.10	"	"	4.15	"
"	1.15	"	"	4.34	"
"	1.20	"	"	4.53	"
"	1.25	"	"	4.72	"
"	1.30	"	"	4.90	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since January, 1891. The price given for each month is the average of the four weekly quotations of that month. Sulphate of ammonia is assumed to contain 20.5 per cent. and nitrate of soda 16.0 per cent. nitrogen, and muriate of potash 50½ per cent. of actual potash or 80 per cent. of pure salt.

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Wholesale Prices of Fertilizing Materials.

		Cost of Nitrogen at wholesale in						Cost of Potash at wholesale in			
		Dried Blood.									
		Red. Cents per pound.	Black or low grade. Cents per pound.	Azotin or Ammonite. Cents per pound.	Concentrated Tankage. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash. Cents per pound.	Available Phosphoric Acid in Dissolved South Carolina Rock. Cents per pound.
1891.	November	12.6	12.3	11.5	....	13.5	14.7	3.68	4.53	4.33	3.69
	December	12.4	12..	11.5	....	13.3	14.7	3.63	4.63	4.41	3.69
1892.	January	12.2	11.5	11.5	....	12.9	14.7	3.62	4.79	4.45	3.69
	February	11.6	11.3	11.5	....	12.0	14.7	3.64	4.77	4.48	3.69
	March	11.5	11.0	11.2	....	12.1	14.7	3.71	4.77	4.48	3.69
	April	11.8	11.3	11.2	....	11.0	14.7	3.78	4.77	4.48	3.69
	May	12.0	11.5	11.2	....	10.5	14.7	3.78	4.77	4.48	3.69
	June	11.7	11.2	11.2	....	10.0	14.7	3.78	4.77	4.48	3.69
	July	12.1	11.7	11.2	....	11.1	14.7	3.78	4.77	4.48	3.69
	August	12.3	12.1	11.2	....	11.7	14.7	3.78	4.77	4.48	3.60
	September	12.4	12.0	12.0	....	12.4	14.2	3.78	4.77	4.48	3.30
	October	13.0	12.6	12.6	....	12.9	14.0	3.78	4.77	4.48	3.30
	November	14.1	13.8	13.7	....	13.7	14.0	3.78	4.77	4.48	3.30
	December	14.6	14.2	14.8	....	13.7	14.0	3.78	4.77	4.48	3.30
1893.	January	16.2	15.8	15.9	12.3	13.8	14 0	3.51	4.25	4.70	3.33
	February	18.5	18.0	17.9	15.7	14.1	14.0	3.56	4.32	4.16	3.09
	March	20.0	19.8	19.6	19.3	14.7	15.6	3.56	4.32	4.16	3.09
	April	18.0	17.7	18.1	19.3	14.6	17.1	3.56	4.32	4.16	3.09
	May	16.2	15.4	16.4	18.3	13.0	17.1	3.56	4.32	4.16	3.09
	June	14.5	14.0	14.8	14.2	11.0	15.9	3.75	4.32	4.16	3.09
	July	13.7	13.1	13.7	14.2	11.1	14.9	3.75	4.32	4.16	3.09
	August	13.5	12.1	13.9	14.2	11.4	15.6	3 75	4.25	4.16	3.09
	September	12.5	12.2	13.2	14.2	11.6	15.9	3.75	4.32	4.16	3.09
	October	16.2	15.3	15.3	17.1	11.9	16.4	3.75	4.32	4.16	3.09
	November	16.6	15.7	16.6	16.3	11.7	16.4	3.74	4.33	4.15	3.09
	December	16.1	15.3	16.1	16.3	11.3	16.4	3.74	4.33	4.15	3.09
1894.	January	15 9	14.7	16.0	15.9	12.0	16 7	3.58	4.30	4.18	3.09
	February	15 9	15.2	15.9	15.4	11.7	18 4	3.71	4.44	4.28	3.09
	March	15.5	14.6	15.5	15.4	13 0	18.5	3.71	4.44	4.28	3.09
	April	14.5	13.9	14.2	13.3	14.0	17.6	3.84	4.54	4.39	2.98
	May	14.5	13.8	14.2	12.2	14.4	16.7	4.13	5.04	4.85	3.00
	June	13.2	12.6	13.1	12.2	14.3	16.7	4.13	5.04	4.85	3 00
	July	12.6	12.6	12.9	12.2	13.8	16.8	4.13	5.04	4 85	3·00
	August	13.3	12.6	13 3	12.3	13.7	17.7	4.13	5.04	4.85	3.09
	September	15.7	14.5	15.4	12.3	13.5	18.3	4.13	5.04	4 85	3.12
	October	15.1	14.4	15.2	12.4	12.9	17.5	4.13	5.04	4.85	3.12
	November	14.1	13.1	14.0	12.3	13.2	16.4	4.13	5.04	4.85	3.00
	December	13.5	12.4	13.1	12.3	12.9	16.0	4.13	5.04	4.85	3.10
1895	January	12.7	12.2	13.0	12.3	12.1	15.0	3.54	4 24	4.13	3.50
	February	11.9	11.2	....	12.3	11.4	15.0	3.54	4.24	4.13	3.37
	March	12.1	10.5	....	12.3	10.4	15.0	3.59	4.32	4.20	3.37
	April	11.7	10.6	....	12.3	10.3	15.0	3.59	4.32	4.20	3.37
	May	12.1	10.8	....	12.3	10.5	14.3	3.59	4.32	4.20	3.37
	June	11.7	10.9	....	12.3	11.0	13.6	3.59	4.32	4.20	3.37
	July	11.6	10.7	....	12.3	10.9	13.4	3.60	4.32	4.20	3.37
	August	11.5	10.2	....	12.3	10.8	13.1	3.60	4.32	4.20	3.37
	September	11.8	10.2	....	12.3	11.3	13.0	3.60	4.32	4.20	3.23
	October	11.8	10.2	....	12.3	11.7	12.2	3.60	4.32	4.20	2.62

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ON THE USE OF COMMERCIAL FERTILIZERS FOR FORCING-HOUSE CROPS.

EXPERIMENTS WITH TOMATOES.

By E. H. Jenkins and W. E. Britton.*

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* The general plan of this work, the arrangement of its details and the preparation of this paper, are our joint work. The horticultural work has been done wholly by Mr. Britton. The chemical work involved has been done by Messrs. Winton and Ogden.

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The use of commercial fertilizers in forcing houses has apparently received little attention from horticulturists. Bulletins Nos. 10 and 15 of the Massachusetts Hatch Station, Bulletin 43 of the Ohio Station and Bulletins 28 and 32 of the New York Cornell Station, contain the only references to work or observations on this subject, which we have been able to find.

Yet to those who are raising or contemplate raising winter crops under glass, the question of substituting fertilizers for manure, in part at least, is a very important one. Forcing-house soil, as it is usually prepared, consists of rich garden soil or rotted turf, composted with from one-fourth to one-half its bulk of horse manure. Aside from the labor of hauling and of repeatedly working over this material to secure the fine mellow condition which is desired, the cost formerly was not great. But the general introduction of electric cars has cut down enormously the production of horse manure in cities which has been the main dependence of our market gardeners. In consequence, the preparation of suitable soil for forcing-houses is increasingly expensive.

Besides this it is found that even a rich natural soil cannot carry forcing-house tomatoes to their highest productiveness, and therefore liquid manure is often used to water the soil after the plants have come into bearing.

The admirable work on the use of commercial fertilizers on field tomatoes, done at the New Jersey Station, has proved that the ripening of the crop may be very materially hastened by the proper use of fertilizer chemicals, especially of nitrate of soda.

To hasten the ripening of crops under glass, where the expense of growing them is so much greater than in the field, must greatly increase the profits of the business.

These considerations have led us to endeavor to determine with all possible accuracy how much plant food various forcing-house crops take from the soil during their growth, and whether commercial fertilizers can be used instead of stable manure, wholly or in part, to supply this plant food.

A further question also connected with these, is, whether the humus of rotted manure, generally regarded as necessary to regulate the storage and circulation of moisture in the soil under natural conditions, can be replaced by some cheap substitute, or dispensed with altogether in forcing-house culture, where the supply of soil moisture can be well regulated by artificial means.

With the resources at our command, only a beginning could be made with the work, in 1895.

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Experiments with Tomatoes.

Our first endeavor was to find out how much *nitrogen* tomato plants raised under glass take from the soil, in their fruit and vines, and how much nitrogen needs to be in the soil to meet fully this demand of the plants.

These questions we studied by raising tomatoes in plots on the forcing-house benches which were filled with a soil known to be practically free from available nitrogen, bnt believed to contain all other ingredients necessary for a maximum tomato crop. To these plots were added known quantities of nitrogen in form of nitrate of soda.

The weight of the fruit harvested, and of the vines which bore it, with the chemical analyses of both, furnish the means of determining how much nitrogen, phosphoric acid and potash a crop of tomatoes takes from the soil. Comparison of the quantities of nitrogen applied to the several plots, with the weights of the crops and of their nitrogen, gives some indication of the amount of nitrogen necessary to apply in order to secure a maximum crop.

To fix the initial quantities of fertilizing ingredients to be used, in the absence of all data, was necessarily guess work, and another season's tests, at least, will be needed to fully solve the questions proposed. But the experiments of 1895 have yet done much towards solving them and have furnished, incidentally, valuable results and suggestions.

We give herewith a full description of the method adopted and the course of the experiment, both being necessary to any judgment of its value.

The Forcing House.

The house was newly erected and designed by ourselves. It is a sash-bar structure made for a general-purpose house, being three-quarters span (nearly), sixteen feet wide by forty feet long, running east and west, and a partition across the centre divides the house into two apartments of equal size. The north and south benches run the entire length but the centre bench is shorter to allow for walks at the ends. The walks are two feet in width. This house is heated by steam, from a boiler which is used for heating all the Station buildings, and which carries a uniform pressure of five pounds of steam, day and night. Entering the house by an overhead flow, the steam passes the length of the house, then downward, and returns through coils of pipe under

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the benches. There are two coils under each of the three benches in either division of the house. Each coil is provided with a valve, so that steam may be passed through any or all of the six different coils, or may be shut off entirely; an arrangement which gives perfect control of the house temperature, even in extremely variable weather.

Ventilation is secured by a continuous line of ventilating sash along the south side, hinged at the ridge.

The north and south walls are both solid (containing no glass). The height of the former is twenty-one inches above the top of the bench, and that of the latter thirty-eight inches. This house has proven to be well adapted for forcing crops which need a high temperature.

Benches and Plots.

The bench selected for our experiments, because thought to have the most favorable exposure, was the centre bench in the east end. This bench runs east and west and is nine inches deep, having a bottom of six inch boards laid three-fourths of an inch apart for drainage. The spaces between the boards were covered with coarse peat, so that none of the soil could escape when the benches were filled. The bench was divided into five plots, each three feet, six and one-half inches by three feet eleven inches, and having an area of 1997½ square inches or 13.87 square feet.

The soil filled the plots to a depth of about eight inches, leaving abundant room after settling for watering. Six plants were set in each plot.

Preparation of the Artificial Soil.

The soil for each plot was separately mixed as follows: 300 pounds of anthracite coal ashes, sifted to pass a wire screen with four meshes to the inch, were spread on a cement floor, and nine pounds of peat moss, such as is sold in the cities for stable bedding, screened like the ashes, were scattered over them. To these were added three and one-half ounces of precipitated carbonate of lime, to neutralize a slight acidity of the peat and give to the whole a mild alkaline reaction. These materials were shoveled over twice carefully and then spread as before.

The fertilizers designed for the plot were sprinkled over this mixture and the whole was carefully shoveled over twice again to secure as perfect a mixture as possible of fertilizers and soil

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and then carried in a hand-barrow to the designated plot in the forcing house.

The north bench in the same division of the house was filled with a rich soil prepared by composting good thick turf with one-third its bulk of stable manure. Plants were set in this bench mainly to make a rough comparison between crops grown on the two radically different soils. The exposure of the two benches is slightly different, that of the north bench being, perhaps, somewhat less favorable as regards light. The plants set in the north bench were also much closer together. The fertilizers used on the several plots may be seen from the table given on page 82.

Plants.

Three varieties were used: Ignotum, Acme and Dwarf Champion, two plants of each variety being set in each plot, and all receiving the same treatment.

The plants were grown from seed sown in flats about September 1st. The seedlings were potted in due time and later shifted to four inch pots, where they remained till they could be set in the plots of the forcing house benches. The earth about the roots was not disturbed in transplanting to the plots, but was sunk in the artificial soil with the plant, so that about two inches of the stem was covered with the soil. Plants were set in the plots of natural soil on December 7th, but could not be set in the artificial soil, plots 4–8, till December 31st, 1894, and January 1st, 1895.

Owing to delay in building the forcing house, the plants were all somewhat "drawn," or "leggy," when placed in the plots. They, however, outgrew their legginess in a large measure, developing into fairly normal specimens, with every appearance of thrift (where the plant food was sufficient) and bearing fruit satisfactorily.

Care during Growth.

The method of training adopted was the "single stem" system, which has been used successfully at the New York Cornell Station. By this system plants can be set closer, and while the yield may be much less *per plant* than under other systems of training, it is as large or larger per square foot of bench-area devoted to the crop.

The plants blossomed soon after setting. The first pollinating was done January 5th. Pollination was effected by holding a

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spoon directly under each flower and gently tapping the upper part of the blossom with a pencil or small stick. Pollen is thus shaken into the spoon and at the same time the stigma is driven into the mass of loose pollen in the bottom of the spoon. The stigmatic surface which is on the end of the style is thus coated with pollen, and as flower after flower is visited on many different plants, cross-fertilization is insured. Flowers were pollinated about every other day throughout the blossoming period.

The plants in all the plots grew finely for a time, though as early as January 8th a slight difference of color was noticeable between the plants in plot 4, which had received no nitrate of soda, and the others; the former being lighter in color. This difference increased through the season.

Plants of the Acme variety were the first to blossom; the others followed next day.

In January a slight curling of the young leaves upon the tips of the most vigorous plants was quite marked. More air and less water righted the difficulty, so that apparently no injurious results followed. This curling was more marked upon plants grown in the natural soil, than upon those grown in the artificial soil.

February 12, the plants growing in plots 6, 7 and 8 were slightly darker in color than those in plot 5. A very slight attack of rot (*Macrosporium tomato*) was first noticed on plants grown in natural soil.

February 24th: A gradation in the color of the plants was very noticeable, being darker green in each successive plot where the amount of nitrate of soda added was greater.

February 27th: The first tomatoes were harvested; three Ignotums from plot 5 and one from plot 8 (artificial soil), and two Ignotums and three Acmes from plot 1 (natural soil).

It was necessary to trim the plants from time to time to give them air and sunlight, as well as for greater convenience in cultivating the soil and gathering the fruit.

The trimmings were saved, and later, together with the plants (stems and foliage), submitted to the chemists for examination.

The plots were watered by the gardener's rule, "Water a plant when it needs it." Judgment alone must determine this. Water was applied from a hose on the surface of the soil and at no time was the soil drenched, so that any loss of fertilizers would occur by leaching. The soil was cultivated every few days with a hand weeder to loosen up the surface and check evaporation. In

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order to keep the atmosphere moist, the walks were wet down every day between nine and ten o'clock, and again in the afternoon on warm sunny days. The plants were never syringed.

The temperature of the house ranged from 60° to 65° Fahr. during the night and from 10° to 15° higher through the day. On warm sunny days the thermometer often registered 85° and even 90°.

Harvesting.

While the color, size and general appearance of the plants give valuable indications, yet as the tomato is grown for its fruit alone, it is in the fruit that we must look for the measure of the practical value of application of fertilizers.

In order to collect all the necessary data on this point, an accurate record of each plant was kept, with the weight and measure of each individual tomato produced by it and with additional notes regarding form, color, etc. Each plant was numbered and each tomato was weighed, the weight (in grams) recorded, and the greatest circumference, determined by passing a measuring tape around the tomato in a plane at right angles to the axis of the fruit, was also recorded.

Chemical Analyses of the Crops.

When the plants were all bearing freely, a number of fruits of both the Acme and Ignotum variety were separately gathered from plants on each of the plots, 4, 5, 6, 7 and 8, and analyzed to determine the amounts of nitrogen, phosphoric acid and potash removed from the several plots in the crops, and incidentally to see if there were any marked differences in the composition of the two varieties of tomatoes or in the composition of the crops on the several plots.

At the close of the experiment the vines and leaves, with the leaves that had been trimmed out during the growing season, were also analyzed, to determine how much nitrogen, phosphoric acid and potash remained in them. It was impracticable to analyze the roots, as no satisfactory separation could be made from the ashes and peat, which do not separate nearly as readily from root fibers as soil.

Tabular Statement of the Plan of the Experiments and the Results.

We give below in tables the statements of yields and composition of tomatoes and vines, followed by a discussion of them.

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TABLE I.—TOMATO EXPERIMENT. FERTILIZERS APPLIED AND CROPS HARVESTED.

Fertilizers applied in grams.	Plot 4.			Plot 5.			Plot 6.			Plot 7.			Plot 8.		
Nitrate of Soda	none.			68.1			113.5			158.9			204.2*		
Equivalent Nitrogen	----			10.9			18.2			25.4			32.7		
Dissolved Bone Black	none.			47.9			47.9			47.9			47.9		
Equivalent Phosphoric Acid	----			8.1			8.1			8.1			8.1		
Muriate of Potash	none.			58.6			58.6			58.6			58.6		
Equivalent Potash	----			29.3			29.3			29.3			29 3		
Total yield of fruit, grams	316			4840			8331			10505			12522		
Variety	Ignotum.	Acme.	Dwarf Champion.	Ignotum.	Acme.	Dwarf Champion.	Ignotum.	Acme.	Dwarf Champion.	Ignotum.	Acme.	Dwarf Champion.	Ignotum.	Acme.	Dwarf Champion.
Yield of each variety, 2 plants, grams	120	155	41	1934	1853	1053	2285	3870	2176	3081	4421	3003	4194	5205	3123
Average yield per plant, grams	60	77.5	20.5	967	926.5	526 5	1142.5	1935	1088	1540.5	2210.5	1501.5	2097	2602.5	1561.5
" " " pounds	.13	.17	.04	2.13	2.04	1.16	2.52	4.27	2.40	3.40	4.88	3.31	4.63	5.74	3.44
Average number fruits per plant	1	1.5	.5	8	12.5	6	8	18.5	11.5	12	19.5	19.5	23.5	23.5	16
Average weight per fruit, grams	60	51.6	41	120.8	74.1	87.7	142.8	104.6	94.6	124.2	113.3	77	89.2	110.7	97.5
Average number of double fruits	0	0	0	0	0	0	.5	1	0	3	.5	.5	0	1.5	.5
" " perfect shaped fruits	0	1.5	.5	0	4.5	2	4	3.5	3.5	3	10.5	7.5	3	11.5	4
Per cent of perfect shaped fruits	0	100	100	0	36	33	50	19	30	25	51	38	13	48	25
Average yield per square foot of bench area grams	25.95	32.52	8.86	418.34	400.82	227.77	494.26	837.11	470.69	666.45	956.30	649.58	907.20	1125.89	675.52
Average yield per square foot of bench area, pounds	.057	.074	.012	.92	.88	.50	1.09	1.84	1.03	1.47	2.11	1.21	2.00	2.48	1.48

* One-half mixed with the soil at setting time, the rest spread on the surface, Feb. 11.

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TABLE III.—COMPOSITION OF TOMATO VINES AND LEAVES AND OF FRUIT.

	AIR-DRY TOMATO VINES AND LEAVES.					FRESH TOMATO FRUIT.									
						Acme Variety.				Ignotum Variety.				Average of	
	Plot 4. %	Plot 5. %	Plot 6. %	Plot 7. %	Plot 8. %	Plot 5. %	Plot 6. %	Plot 7. %	Plot 8. %	Plot 5. %	Plot 6. %	Plot 7. %	Plot 8. %	18 Maryland Analyses.*	12 New Jersey Analyses.†
Water	3.92	7.57	7.90	7.81	8.02	93.41	94.07	94.17	94.81	93.97	94.53	94.54	94.79	94.75	
Phosphoric Acid	1.85	.92	.64	.49	.51	.066	.052	.052	.053	.062	.057	.061	.059		
Potash	2.69	3.84	3.88	3.58	3.44	.356	.295	.334	.287	.339	.338	.345	.303		
Nitrogen	.73	.95	1.00	1.12	1.38	.079	.089	.118	.139	.082	.099	.118	.145		
						WATER-FREE.									
Phosphoric Acid	1.91	.99	.70	.53	.56	1.00	.87	.90	1.02	1.03	1.04	1.11	1.13	1.01	1.13
Potash	2.80	4.15	4.21	3.90	2.65	5.40	4.97	5.73	5.53	5.62	6.19	6.32	5.81	5.93	4.31
Nitrogen	.76	1.03	1.09	1.21	1.50	1.20	1.50	2.03	2.68	1.36	1.81	2.16	2.78	3.35	2.09

* Md. Sta. Bull. 11. Raised in field.

† N. J. Sta. Bull. 63. Raised in field.

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Equivalent Nitrogen	----			10.9			18.2			25.4			32.7		
Dissolved Bone Black	none.			47.9			47.9			47.9			47.9		
Equivalent Phosphoric Acid	----			8.1			8.1			8.1			8.1		
Muriate of Potash	none.			58.6			58.6			58.6			58.6		
Equivalent Potash	----			29.3			29.3			29.3			29 3		
Total yield of fruit, grams	316			4840			8331			10505			12522		
Variety	Ignotum.	Acme.	Dwarf Champion.	Ignotum.	Acme.	Dwarf Champion.	Ignotum.	Acme.	Dwarf Champion.	Ignotum.	Acme.	Dwarf Champion.	Ignotum.	Acme.	Dwarf Champion.
Yield of each variety, 2 plants, grams	120	155	41	1934	1853	1053	2285	3870	2176	3081	4421	3003	4194	5205	3123
Average yield per plant, grams	60	77.5	20.5	967	926.5	526 5	1142.5	1935	1088	1540.5	2210.5	1501.5	2097	2602.5	1561.5
" " " pounds	.13	.17	.04	2.13	2.04	1.16	2.52	4.27	2.40	3.40	4.88	3.31	4.63	5.74	3.44
Average number fruits per plant	1	1.5	.5	8	12.5	6	8	18.5	11.5	12	19.5	19.5	23.5	23.5	16
Average weight per fruit, grams	60	51.6	41	120.8	74.1	87.7	142.8	104.6	94.6	124.2	113.3	77	89.2	110.7	97.5
Average number of double fruits	0	0	0	0	0	0	.5	1	0	3	.5	.5	0	1.5	.5
" " perfect shaped fruits	0	1.5	.5	0	4.5	2	4	3.5	3.5	3	10.5	7.5	3	11.5	4
Per cent of perfect shaped fruits	0	100	100	0	36	33	50	19	30	25	51	38	13	48	25
Average yield per square foot of bench area grams	25.95	32.52	8.86	418.34	400.82	227.77	494.26	837.11	470.69	666.45	956.30	649.58	907.20	1125.89	675.52
Average yield per square foot of bench area, pounds	.057	.074	.012	.92	.88	.50	1.09	1.84	1.03	1.47	2.11	1.21	2.00	2.48	1.48

* One-half mixed with the soil at setting time, the rest spread on the surface, Feb. 11.

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TABLE III.—COMPOSITION OF TOMATO VINES AND LEAVES AND OF FRUIT.

	AIR-DRY TOMATO VINES AND LEAVES.					FRESH TOMATO FRUIT.									
						Acme Variety.				Ignotum Variety.				Average of	
	Plot 4. %	Plot 5. %	Plot 6. %	Plot 7. %	Plot 8. %	Plot 5. %	Plot 6. %	Plot 7. %	Plot 8. %	Plot 5. %	Plot 6. %	Plot 7. %	Plot 8. %	13 Maryland Analyses.*	12 New Jersey Analyses.†
Water	3.92	7.57	7.90	7.81	8.02	93.41	94.07	94.17	94.81	93.97	94.53	94.54	94.79	94.75	
Phosphoric Acid	1.85	.92	.64	.49	.51	.066	.052	.052	.053	.062	.057	.061	.059		
Potash	2.69	3.84	3.88	3.58	3.44	.356	.295	.334	.287	.339	.338	.345	.303		
Nitrogen	.73	.95	1.00	1.12	1.38	.079	.089	.118	.139	.082	.099	.118	.145		
						WATER-FREE.									
Phosphoric Acid	1.91	.99	.70	.53	.56	1.00	.87	.90	1.02	1.03	1.04	1.11	1.13	1.01	1.13
Potash	2.80	4.15	4.21	3.90	2.65	5.40	4.97	5.73	5.53	5.62	6.19	6.32	5.81	5.93	4.31
Nitrogen	.76	1.03	1.09	1.21	1.50	1.20	1.50	2.03	2.68	1.36	1.81	2.16	2.78	3.35	2.09

* Md. Sta. Bull. 11. Raised in field.

† N. J. Sta. Bull. 63. Raised in field.

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TABLE IV.—QUANTITIES OF NITROGEN, PHOSPHORIC ACID AND POTASH, TAKEN FROM EACH PLOT BY CROP (IN GRAMS).

	Plot 4.			Plot 5.			Plot 6.			Plot 7.			Plot 8.		
	Fruit.	Vines.	Total.	Fruit.	Vines.	Total.	Fruit.	Vines.	Total.	Fruit.	Vines.	Total.	Fruit.	Vines.	Total.
Nitrogen	.25	.30	.55	3.88	2.46	6.34	7.64	3.61	11.25	12.40	4.61	17.01	17.66	5.57	23.23
Phosphoric Acid...	.20	.75	.95	3.12	2.38	5.50	4.45	2.31	6.76	5.74	2.02	7.76	6.89	2.06	8.95
Potash	1.11	1.09	2.20	16.90	9.95	26.85	25.56	13.99	39.55	35.43	14.73	50.16	36.61	9.85	46.46

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TABLE II.—YIELD OF AIR-DRY VINES AND OF FRESH FRUIT ON EACH PLOT (IN GRAMS).

	Vines.	Fruit.
Plot 4	40.5	316
" 5	259.0	4,840
" 6	360.5	8,331
" 7	411.5	10,505
" 8	403.5	12,522

DISCUSSION OF THE CHEMICAL DATA OF THE EXPERIMENT.

1. The artificial soil of itself contained very little, if any, nitrogen available to tomatoes. Six plants with their fruit growing on it contained only half a gram (seven and one-half grains) of nitrogen, and a portion of this came from the young plants and their adhering earth, which were set in this artificial soil.

2. The four plots, 5, 6, 7, 8, with regularly increased applications of nitrogen, show an increasing yield of fruit, of average number of fruits per plant, and of nitrogen, phosphoric acid and potash* in the crop. Table V. presents these facts:

TABLE V.—STATISTICS REGARDING THE CROPS OF TOMATOES (FRUIT AND VINES) ON THE FIVE PLOTS OF ARTIFICIAL SOIL.

	Amount of Nitrogen added.	Weight of Fruit	Average number of Fruits per plant.	Average weight of a single Fruit.	Yield of Crops in		
					Nitrogen.	Phos. Acid.	Potash.
	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Plot 4..	0.0	316	1.0	50.8	.55	.95	2.20
Plot 5..	10.9	4840	8.8	99.6	6.34	5.50	26.85
Plot 6..	18.2	8331	12.6	112.5	11.25	6.76	39.55
Plot 7..	25.4	10505	17.0	103.1	17.01	7.76	50.16
Plot 8..	32.7	12522	21.0	99.1	23.23	8.95	46.46

It is altogether probable that the tomato plants in this experiment needed more than the quantity of nitrogen applied to plot 8, in order to yield their maximum crop. Of the total nitrogen added, at least 58 per cent. was taken by the crop on plot 6, 65 per cent. on plot 7, and 69 per cent. on plot 8. This increased per cent. of assimilation also indicates that the plants that received most nitrogen still had no excess.

3.—It appears also that the quantities of both phosphoric acid and potash which were added to the plots in fertilizers, were

* Excepting Plot 8.

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entirely insufficient for the needs of the maximum tomato crop, but that the plants were able to obtain some phosphoric acid and very considerable quantities of potash from the coal ashes. The following statement shows this :

TABLE VI.—QUANTITIES OF PHOSPHORIC ACID AND POTASH IN THE FERTILIZER AND IN THE CROP (FRUIT AND VINES).

	Plot 5. Grams.	Plot 6. Grams.	Plot 7. Grams.	Plot 8. Grams.
Phosphoric Acid applied	8.14	8.14	8.14	8.14
Phosphoric Acid harvested	5.50	6.76	7.76	8.95
Potash applied	29.30	29.30	29.30	29.30
Potash harvested	26.85	39.55	50.16	46.46

On three of the plots the potash added in fertilizers was certainly insufficient, and on two at least phosphoric acid was deficient.

Whether the chemical fertilizers and the coal ashes together supplied all the potash and phosphoric acid which the crops needed, or whether the plants on plot 8 suffered for lack of potash or phosphoric acid as well as of nitrogen, cannot now be determined.

It is not certain that the available potash and phosphoric acid came from the coal ashes themselves. Possibly the kindlings or waste, which is sometimes burned in the furnace in very small amount, supplied them.

4.—Tomato plants grown in artificial soil, under the conditions of our experiment, actually removed from the soil in fruit, vines, and leaves :

	Per Plant. Grams.	Per 100 square feet of bench. Grams.
Nitrogen	3.87	167.5
Phosphoric Acid	1.49	64.5
Potash	8.36	361.7

These are equivalent to the following quantities of nitrate of soda (16 per cent. nitrogen), dissolved bone black (17 per cent. available phosphoric acid) and muriate of potash (50 per cent. potash).

	Per Plant. Grams.	Ounces.	Per 100 square feet of bench. Pounds and Ounces.
Nitrate of Soda	24.2	.86	2 and 5
Dissolved Bone Black	8.8	.31	0 and 13
Muriate of Potash	16.7	.59	1 and 9

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These are the quantities actually contained in the crop, exclusive of the root system.

If the soil used were quite free from all available nitrogen, phosphoric acid and potash, from one-third to one-half or even more than the quantities named might be needed to produce the crop, because, as our vegetation experiments and those of others have indicated, plants are not able to assimilate, even in extreme cases, more than 75 or 80 per cent. of the soluble plant food in the soil, and because in these observations no account has been taken of the fertilizing materials contained in the roots.

5.—The composition of the two varieties of tomatoes as respects ingredients named in the table, is very nearly alike, the Ignotum in every case having a very slightly higher percentage of nitrogen, phosphoric acid and potash, than the Acme.

The average of twelve analyses of the dry matter of tomatoes raised in the field, differently fertilized, New Jersey Agricultural Station Bulletin 63, and also the average of eighteen analyses, Maryland Agricultural Station, Bulletin 11, are given in the table on page 83. The comparison shows that as far as these four ingredients were concerned normal fruit was raised in this artificial soil with commercial fertilizers.

6.—Every 100 pounds of ripe tomatoes removed from the soil the equivalent of:

400 grams or 14 ounces of Nitrate of Soda.
147 grams or 5 ounces of Dissolved Bone Black.
266 grams or 10 ounces of Muriate of Potash.

Discussion of the Horticultural Data.

The increase of weight of the crops of each variety, with each successive increase in the nitrogen added in the fertilizer, and the like increase in the average number of fruits per plant of each variety, have already been discussed.

1.—The highest average weight per fruit of the Ignotum variety was on plot 6, of the Acme on plot 7, and of the Dwarf Champion on plot 8.

2.—The tendency to bear double flowers, which produced irregular-shaped fruit, seemed to bear no relation to the quantity of nitrogen applied, nor to the variety. The same plant produced both single and double blossoms.

3.—The number of perfect fruits was absolutely larger on the

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plots receiving most nitrogen, but there was no very marked relative increase in number.

Bailey found*, however, that plots which were most highly fertilized gave the smoothest fruit.

4.—Comparison of the three varieties shows that Acme gave the largest yield in artificial soil, but the yield of Ignotum was considerably the largest of the three, when grown in rich garden soil.

Acme gave the greatest average number of tomatoes per plant, while the average weight per fruit of Ignotum was considerably greater than that of the other varieties.

5.—The Dwarf Champion proved to be an unprofitable variety in this test.

6.—Tomatoes from the unfertilized plot (Plot 4) were small, smooth and of good shape, but the color was not normal. They were too light in color and slightly rusty-looking,—having a faded appearance. The flesh of the tomato was very dry, and sweet to the taste—much sweeter than tomatoes from other plots.

Tomatoes of best form, size and color grew upon plots 6 and 7. Those from plot 8 (and a few from plot 7) ripened very unevenly, and were green about the stem when the other side of the fruit was of good color and apparently ripe. These tomatoes had a decided tendency toward softness while still green; the form and size were very good.

Comparison of Plants Grown in Natural Soil with those Grown in Artificial Soil.

As has been noted above, there were, in the same house with the experimental plots, a considerable number of plants grown in natural soil prepared as described on page 79. These were set much closer in the bench than those grown in artificial soil. The latter had a bench space of 2.31 square feet per plant, the former about 1.15 square feet.

The plants in soil had three weeks the start of those in ashes and peat, being set in the beds on December 7th, while the plants were not set in the ashes and peat until December 31st.

These facts render any very strict comparison of the two impossible, nor was strict comparison intended when the experiment was begun.

* Cornell Station Bulletin No. 10, page 116.

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The following facts, however, deserve notice. In what follows we refer only to the crops grown on plots 7 and 8. The others, 4, 5 and 6, had no adequate supply of nitrogen, and it must also be borne in mind that plots 7 and 8 in all probability did not have a full supply of either nitrogen, phosphoric acid or potash. The tomatoes grown in ashes and peat grew and fruited much more rapidly than those in natural soil, and then suddenly stopped their growth and bearing, the leaves turned brown and the plants appeared to be dead. They were not dead, however, by any means, and after cutting back to near the roots and *supplying more fertilizers*, they made a new and vigorous growth and fruited again.

The plants grown in natural soil, however, kept bearing a little fruit till the following July, when they were thrown out to make room for other experiments.

We believe the plants in peat and ashes fruited more quickly and abundantly, because they had at first a larger supply of soluble plant food than those in natural soil :—that when that was exhausted, they had no resource and died back in consequence :—that if they had been sufficiently fertilized, they would have proved far more prolific and profitable than those in natural soil. To decide this will be one point in next year's experiments.

The following statement gives the average yield per plant of the three varieties (4 plants of each) on plot 8 in artificial soil with commercial fertilizers, also the average yield per plant (an equal number of each of the three varieties was used to calculate this) of the three varieties grown in rich natural soil up to April 17th, the date when, as already described, the plants in artificial soil died back for lack of nourishment. Up to this date the plants had been growing in the natural soil three weeks longer than in the artificial soil. The total yield of the plants in natural soil, up to July 16th, is also given, though after the middle of April there is little or no profit in forcing-house tomatoes.

TABLE VII.—AVERAGE YIELD PER PLANT IN NATURAL AND IN ARTIFICIAL SOILS.

	Peat and Ashes with Fertilizers.	Natural Soil.	
	To April 17th.	To April 17th.	To July 16th.
Yield per Plant (grams).....	2087	976	1820
Yield per Plant (pounds)....	4.59	2.15	4.00
Number of Fruits per Plant..	21	10.4	22.7
Weight of Fruits (grams)....	99.1	91.7	82.4
Yield per square foot (grams)	904	847.0	1583
Yield per square foot (pounds)	1.99	1.86	3.5

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The table shows that up to the time when the fertilizers in the artificial soil were proved (by the chemical analyses) to be exhausted, the plants in artificial soil had produced, per square foot of bench space, seven per cent. more tomatoes than those in the natural soil, while the latter had, up to that time, three weeks more of growing season.

It is possible that the plants in natural soil, if they had been set further apart, would have, in the same time, made a larger crop per foot of bench space. It is possible too, that with an increased supply of fertilizers the plants in artificial soil would have given a largely increased yield. We cite these figures only to show that the tomato crop can be successfully grown in a soil made of ashes and peat, such as we have described, with the aid of commercial fertilizers.

Summary.

1.—A forcing-house tomato crop yielding about two pounds of fruit for each square foot of bench room, takes in the vines and fruit, for every hundred square feet of bench space, not less than:

	Grams.			Pounds.	Ounces.
Nitrogen	168	Equivalent to	Nitrate of Soda	2	5
Phosphoric Acid	65	"	" Dissolved Bone Black	0	13
Potash	362	"	" Muriate of Potash	1	9

Of this from a fourth to a fifth only is in the vines.

2.—To enable the plants to get these fertilizer elements as required, there should be a large excess of them in the soil, perhaps double the quantity given above.

3.—Every 100 pounds of tomato fruit takes from the soil approximately:

	Ounces.			Ounces.
Nitrogen	2.2	Equivalent to	Nitrate of Soda	14
Phosphoric Acid	0.9	"	" Dissolved Bone Black	5
Potash	4.6	"	" Muriate of Potash	10

4.—It is possible to grow a crop of forcing-house tomatoes, amounting to two or more pounds per square foot of bench space, perfectly normal in size, color, taste and chemical composition, by the aid of commercial fertilizers alone, and in soil composed of coal ashes and peat.

The scope of these experiments has been considerably enlarged and they will be continued during the season of 1895 and 1896.

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THE USE OF AN ARTIFICIAL SOIL AND COMMERCIAL FERTILIZERS IN FORCING-HOUSES.

By E. H. Jenkins and W. E. Britton.

We are not at present prepared to recommend any departure from those methods of raising a forcing-house crop of tomatoes which experience has approved.

The experiments of a single season and of a single observer, and on the very small scale made necessary by our limited space, are necessarily quite inconclusive.

Moreover these experiments were not undertaken with the object of learning whether artificial soil could be generally used in forcing-houses as a substitute for natural soil, but solely to determine how much nitrogen in the soil was necessary for the full development of the tomato plant.

Yet we feel justified in calling attention to certain apparent advantages in using the artificial soil which we have described.

Cost.

For every 100 square feet of bench space, about 2200 pounds of sifted coal ashes and 63 pounds of dried peat or leaf mold is required to fill the bench eight inches deep with soil. Experiments are now in progress to determine whether the use of peat is necessary.

About 10 pounds of commercial fertilizers are needed for this bench space, costing, at present ruling ton rates, less than 21 cents. The cost of these things is to be compared with the cost of providing a considerably greater weight of rich compost containing a large relative amount of stable manure.

In very many cases, the cost of filling the benches with the artificial soil must be very much less than the cost of filling them with rich garden soil.

Early Maturing of Crop.

The greatest expense in running a forcing-house is the artificial heat required, and for this reason, quick growth and early maturity are extremely desirable. Regarding the relative availability

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of the potash and phosphates in compost and in commercial fertilizers, we know little, but it is very certain that the nitrogen of composts is slowly available as compared with the nitrogen of nitrates.

Our tomato tests above described showed too, very clearly, that plants in natural soil made much slower growth and were slower in fruiting than those in artificial soil supplied with nitrates. Though the former were set fully three weeks earlier, both began fruiting at the same time. These facts have already been shown on page 89.

Freedom from Insects and Fungi.

The coal ashes, which constitute about 97 per cent. of the artificial soil, are of course absolutely free from all forms of life, when taken for forcing-house use. This is, by itself considered, an advantage.

The peat, while by no means free from low forms of life, is yet far less adapted to their existence and growth than the rich garden soil. It was noticed, when the benches were cleared out in the summer, that the wood under the artificial soil was hard and sound, while under the natural soil it had decayed quite perceptibly in a single season through the agency of the microbe life in the soil, of which the artificial soil was comparatively destitute.

Freedom from Nematodes in Particular.

Tomatoes grown under glass are usually attacked at the root by a species of small worms known as Nematodes (*Heterodera radicicola*), which induces the well known root-galls.

The soil becomes so infested with these worms that it cannot be used two seasons in succession for tomatoes.

The practice, therefore, is to throw it out and let it lie over one winter. Freezing the soil greatly diminishes the number of the nematodes, so that it can be used in the forcing-house again the third season.

Wherever natural soil was used in our tests, we found the roots thoroughly infested with nematodes and covered with galls. On the contrary, where artificial soil was used, no root-galls whatever were found beyond the ball of earth set with the plant. In this they were quite abundant.

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ON THE CHEMICAL COMPOSITION OF LETTUCE GROWN IN THE FORCING-HOUSE.

By E. H. Jenkins and W. E. Britton.

Experiments of the same kind as those fully described in the previous paper, page 75 of this Report, have been made with lettuce.

Extended notice of them is deferred till further tests are completed, but the following data have value apart from their connection with our special line of work and are accordingly given here.

The house was not well adapted for growing lettuce, being fitted with benches and bottom heat instead of solid beds.

Each plot, 3 feet 11 inches by 2 feet 11½ inches, had an area of 11⅓ square feet and 200 pounds of the peat and ashes mixture filled it to the depth of six inches. The mixture contained five per cent of peat moss.

The variety of lettuce grown was Simpson's White Seeded Tennis Ball. The seed was sown in flats and as soon as the plants were large enough to handle they were pricked out four inches apart each way on the bench. They remained here until ready to be transferred to the experimental plots, when they were set eight inches apart each way, making thirty plants in each plot.

The quantities of plant food added to this soil are shown in the table, which also presents in detail the results of the experiment.

When the crop was harvested, the lettuce heads were cut close to the surface of the soil, immediately weighed in their fresh condition, and dried for analysis.

The roots were pulled and the soil separated as well as could be, but as is seen by the large amount of matter "insoluble in acid" the separation was quite imperfect and a part of the fertilizing elements found on analysis had not really entered the roots, but was in the adhering soil. The chemical analyses were made by Messrs. Winton and Ogden.

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TABLE I.—FERTILIZERS APPLIED AND CROPS HARVESTED (IN GRAMS).

Fertilizers applied.	Plot 38.	Plot 39.	Plot 40.	Plot 41.
Nitrogen	7.11	11.85	16.59	21.34
Equivalent Nitrate of Soda	44.4	74.0	103.7	133.4
Phosphoric Acid	6.80	6.80	6.80	6.80
Equivalent dissolved Bone Black	40.0	40.0	40.0	40.0
Potash	24.24	24.24	24.24	24.24
Equivalent Muriate of Potash	48.5	48.5	48.5	48.5
Crops harvested.				
Lettuce Heads	1232.8	2217.6	2720.6	3083.1
Lettuce Roots*	219.6	361.3	368.4	368.5
Total	1452.4	2578.9	3089.0	3451.6
Dry Substance of Crop	205.5	346.2	349.56	358.33

TABLE II.—COMPOSITION OF THE FRESH PLANTS.

	Plot 38.		Plot 39.		Plot 40.		Plot 41.	
	Roots.	Heads.	Roots.	Heads.	Roots.	Heads.	Roots.	Heads.
Water	60.66	90.33	53.84	91.89	60.16	92.56	60.82	93.06
Nitrogen	.196	.186	.237	.221	.235	.236	.229	.247
Phosphoric Acid	.148	.100	.130	.088	.102	.076	.103	.073
Potash	.292	.563	.293	.564	.321	.566	.317	.566
Insoluble in Acid	20.76	....	27.69	....	22.31	....	21.87	....

TABLE III.—THE QUANTITIES OF NITROGEN, PHOSPHORIC ACID AND POTASH TAKEN UP BY THE CROPS (IN GRAMS).

	Plot 38.			Plot 39.			Plot 40.			Plot 41.		
	Roots.	Heads.	Total.	Roots.	Heads.	Total.	Roots.	Heads.	Total.	Roots.	Heads.	Total.
Nitrogen	.43	2.29	2.72	.86	4.90	5.76	.87	6.41	7.28	.85	7.63	8.48
Phosphoric Acid	.32	1.22	1.54	.47	1.94	2.41	.37	2.07	2.44	.38	2.25	2.63
Potash	.64	6.94	7.58	1.06	12.52	13.58	1.18	15.40	16.58	1.17	17.46	18.63
Ratio of Phosphoric Acid to Nitrogen and Potash	1:1.8:4.9			1:2.4:5.6			1:3.0:6.8			1:3.2:7.0		

The facts which this experiment has developed may be summarized as follows:

1. Lettuce of good quality can be grown under glass in an artificial soil such as we have described, with the use of commercial fertilizers. We are not prepared to say at present that its quality is as good as the best lettuce grown in rich, natural soil.

2. A crop of forcing-house lettuce, raised as above described, takes from the soil in roots and heads, per 1000 heads, not less than:

	Grams.		Pounds.	Ounces.	
Nitrogen	282.6	Equivalent to	3	15	Nitrate of Soda
Phosphoric Acid	87.7	"	1	2	Dissolved Bone Black.
Potash	621.0	"	2	10	Muriate of Potash.

* With much adhering soil.

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3. To supply this plant food to the soil under the conditions of our experiment, it was necessary to add to the soil the following quantities of fertilizers per 1000 plants, or per 387 square feet, the area used in our experiment for 1000 plants.

	Pounds.	Ounces.	Costing cents.
Nitrate of Soda.....	9	13	25
Dissolved Bone Black..	2	15	4
Muriate of Potash.....	3	8	7
			36

Loss of Fertilizer-Nitrogen.

It may not be out of place, in a discussion of the nitrogen-supply for the soil of forcing houses, to call attention to some recent observations regarding the loss of nitrogen, not only from stable manure itself, but from nitrogenous fertilizers of various kinds, nitrates, ammonia salts, urine, fresh vegetable matter, etc., when they are used in connection with stable manure.

It has been known for some time that in full access of air, the nitrogen of nitrates as well as that of organic matters occurring in manure, may be lost as nitrogen gas by the action of microbes.

That losses similar in kind, if much less considerable in amount, may occur in soils, is perhaps not as fully established, but seems quite probable.

Wagner, as the result of carefully made vegetation experiments, concludes that the nitrogen of *well rotted* stable manure is very much less readily available to plants than has been generally supposed. In Wagner's trials the availability of the nitrogen of nitrates being taken as 100 per cent., that of the nitrogen of rotted stable manure was about 45 per cent., while that of various other organic matters commonly used as fertilizers ranged from 60 to 70 per cent.

On the other hand, Kühn found as a result of somewhat similar tests, that if the availability of the nitrogen of sulphate of ammonia (itself a little less quickly available than nitric nitrogen perhaps) was called 100 per cent., that of *fresh* cattle dung was 92 per cent.

This disagreement between the observations of the two experimenters is to be explained probably by differences in the kind of microbe life of the soil or manure, or in the conditions affecting this microbe life, during the course of the experiment, depending on the age and keeping of the stable manure or dung.

In connection with his experiments, Wagner observed that nitrates dissolved in a water-extract of *fresh* horse dung, were

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destroyed with liberation of free nitrogen. When its microbes are killed dung does not have this effect.

What is particularly new and striking in Wagner's observations, however, is that *fresh* dung used with nitrates or with green vegetable substances as a fertilizer, may so depress their fertilizing effect, that the increase of crops secured by the horse dung and nitrates, etc., together, may be less than is produced by the nitrates, etc., alone. The following statement of the yields, in one of his experiments, shows this fact :

No. of Experiment.		Fertilizer used.	Dry matter of Crop (grams).	Of 100 parts of nitrogen in fertilizer there was recovered in the Crops.
1	Without fresh horse-dung.	No added nitrogen.....	13.5	....
2		1 gram nitrogen added as nitrate	85.7	65
3		1 gram nitrogen added as green vegetable matter	74.6	38
4	With fresh horse-dung, supplying 2 grams nitrogen.	No added nitrogen.....	2.9	....
5		1 gram nitrogen added as nitrate	50.7	10
6		1 gram nitrogen added as green vegetable matter	15.1	4

Here it appears that soil, to which were added three grams of nitrogen, viz: two grams in form of *fresh* horse dung and one gram in form of nitrate of soda, yielded a very considerably smaller crop than the same soil to which one gram of nitrate nitrogen was added *without* dung.

This, according to Wagner, is explained by the fact that the microbes in the *fresh* dung expelled nitrogen in the gaseous form, both from the dung itself and from the nitrate, before vegetation could assimilate it.

While the horse dung applied in Wagner's trials was fresh and the quantities were much larger than are ordinarily used in farm practice, yet the facts above cited have a very important bearing on the use of fresh stable manure and possibly on the value of composts, such as are used for forcing-house soil, in which the proportion of stable manure is approximately near to that which was used in Wagner's tests, where a large loss of nitrogen was observed.

It might, therefore, happen that applications of nitrates or other nitrogenous fertilizers to the soil of the forcing-house, would have no marked effect on the crop, while nevertheless available nitrogen was deficient and the crop suffering in consequence. This result might at least be expected to follow the use of fresh-manure water.

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A few observations made at this Station bearing on this subject may here be recorded:

Fifty grams of surface soil from the Station garden, (which is annually dressed liberally with mixed cow and horse manure and with fertilizer chemicals), 50 grams of fresh cow dung and 50 grams of fresh horse dung were stirred up with water, each in a separate vessel and the muddy liquids were strained through tufts of glass wool. This was repeated till the volume of the filtered liquid amounted in each case to 750 c. c. To each was then added five grams of sodium nitrate and water to make 1000 c. c.

Nitrogen as nitrates was immediately determined in each solution. The flasks were tightly stoppered and kept in a closet, nearly dark. From time to time nitrogen was again determined, as shown in the following statement, which gives the weight of nitric nitrogen (in grams) found in 25 c. c. of these solutions on the dates named and the corresponding per cent. loss of nitrogen:

	Nitrate with extract of garden earth.		Nitrate with extract of fresh horse-dung.		Nitrate with extract of fresh cow-dung.	
	Nitrogen.	Per cent. loss.	Nitrogen.	Per cent. loss.	Nitrogen.	Per cent. loss.
March 23...	.0195	....	.0190	....	.0192	....
March 30...	.0196	....	.0172	*9.5*	.0178	*7.3*
April 5...	.0193	*1.0*	.0166	*12.6*	.0180	*6.3*
April 23...	.0190	*2.6*	.0160	*15.8*	.0171	*10.9*
May 24...	.0195	....	.0155	*18.4*	.0173	*9.9*
Nov. 20...	.0193	*1.0*	.0160	*15.8*	.0165	*14.1*
Jan. 28...	.0186	*4.6*	.0167	*12.1*	.0162	*15.6*

It appears that in the extract of garden soil, very little nitrogen was lost through reduction of nitrates during ten months.

The extracts of fresh horse dung and fresh cow dung, caused considerable loss of nitrogen from the nitrates by reduction. The reduction by the extract of cow dung was in this experiment somewhat slower and less in amount than that of the horse dung.

While the gains and losses of nitrate nitrogen in several cases are within the limits of analytical error, it is probable that in the extract of horse-dung after May 24, nitrates began to increase by nitrification of the organic nitrogen.

In a further experiment two extracts were prepared in precisely the way above described, the one from 50 grams of fresh horse dung, the other from 50 grams of a potting soil prepared for use in the forcing house. This was made of pasture sod and the soil just beneath, composted with about one-third their bulk of mixed

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horse and cow manure. The mixture made in the summer of 1894 had stood in a conical compact pile, exposed till the fall of 1895. The soil for this experiment was taken from the interior of this pile at a depth of 2–3 feet.

To each of the extracts prepared as above and measuring 1000 c.c., five grams of nitrate of soda were added.

The following table shows the quantity of nitrogen as nitrates and the losses found at various dates in these two preparations:

	Extract of Potting Soil.		Extract of fresh horse-dung.	
	Nitrogen.	Per cent. loss.	Nitrogen.	Per cent. loss.
Nov. 22.....	.0201	....	.0200	....
Dec. 21.....	.0194	*3.5*	.0192	*4.0*
Jan. 28.....	.0186	*7.5*	.0164	*18.0*

While the surface soil of the garden referred to on page 94, although heavily dressed each year with stable manure, had little or no effect in destroying nitrates, the potting earth (made by composting contiguous pasture sod and a few inches of underlying soil with stable manure), reduced nitrates to about half the extent caused by fresh horse dung.

This result is in accord with familiar facts. The surface soil of tilled ground is commonly or always charged with oxidizing and nitrifying organisms. Fresh and damp compost heaps where vegetable or animal matters are abundant and the soil of forests, low meadows and bogs, contain little or no nitrates, and their bacterial growths are of the deoxidizing or reducing kinds. It is probable that, near the surface of the heap of potting earth, nitrifying organisms were abundant at the very time when the sample taken from the interior was found to have a denitrifying effect.

Accordingly the use of potting earth from the exterior of a compost heap may occasion no loss of nitrate-nitrogen, while earth from the interior of the heap may reduce nitrates and cause serious waste of any nitrate that is applied as a fertilizer.

It is therefore advisable, sometime before using potting compost, to place it under cover away from rain, and to intermix it thoroughly and frequently and to keep it in rather shallow heaps.

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VEGETATION EXPERIMENTS ON THE AVAILABILITY OF NITROGEN IN CERTAIN NITROGENOUS MATERIALS.

By S. W. Johnson, W. E. Britton and E. H. Jenkins.

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The experiments here described are a continuation of work done in previous years, references to which are given in the Eighteenth Report of this Station, 1894, page 73.

Mr. Britton has had entire charge of the preparation of the seed and soil, filling the pots and caring for the crops through the whole period of growth.

All the chemical work involved has been done by Messrs. Winton and Ogden, chemists of the Station.

Scope of the Vegetation Experiments of 1895.

In 1894 we studied the availability of nitrogen by vegetation experiments with maize, grown in pots of artificial soil, and supplied with relatively small quantities of nitrogen in various fertilizers.

The availability of the nitrogen in each case was measured by the quantity of nitrogen which the crop took from the fertilizer.

The artificial soil itself contained only traces of available nitrogen, but all the other elements of plant food were present in excess of the crop requirements.

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If from 10 grams of nitrogen in form of nitrate, growing maize takes up 6 grams, while under exactly the same conditions from the same quantity of nitrogen in form of blood it takes up but 5 grams, the comparative availability of nitrate-nitrogen and blood-nitrogen is as 6 to 5 or as 100 to 83.3.

But a single crop cannot take all the nitrogen even of a nitrate from the soil, because, for one reason, the plant roots do not reach every particle of the soil. 73 per cent. is the largest proportion of the soil-nitrogen which a single crop has been able to secure in our experiments.

Still less can one crop take all the nitrogen from those animal or vegetable matters which decompose but slowly in the soil. In any case therefore more or less fertilizer-nitrogen fails to enter the crop.

In the case just given, 4 grams of nitrate nitrogen and 5 grams of blood nitrogen remain in the stubble, roots and soil, or pass into the air. The question at once arises, may not the 5 grams of blood nitrogen supply more nitrogen to the next crop than the 4 grams of nitrate nitrogen? If so, the results of a single year's cropping do not give the full value of blood-nitrogen as compared with nitrate nitrogen. The after-effects of both must be studied.

To do this, additional quantities of the same forms of nitrogen were mixed with the soil of the pots that had been used in the tests of 1894, and in 1895 they were made to bear a crop of oats followed by a crop of maize. From the quantities of nitrogen which these crops contained is calculated the availability of nitrogen as before.

Now if in the second year for every 6 grams of nitrogen taken by the crop from nitrate, 5½ grams are taken by the crop from blood, instead of 5 as in the first year, this extra ½ gram must have come from nitrogen applied the previous year, which had become available to the second year's crop, and the relative availability of the two forms of nitrogen is by so much nearer alike.

The artificial soil in our experiments was impregnated with a watery infusion of rich garden earth, but the conditions affecting microbic life may be quite different in a mixture of peat and ashes from those which obtain in natural soils, and it is likely that the relative availability of nitrogen in various vegetable and animal matters may differ in different kinds of soil, because the rapidity with which a nitrogenous organic substance decomposes

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and yields its nitrogen to plants largely depends on the character and activity of the microbes within the soil, which appear to be much influenced by texture, tillage and various conditions.

These considerations led us to make two parallel series of vegetation experiments in addition to those here described; one with soil taken from under old pasture turf which had not been broken up for thirteen years, nor top-dressed for ten years; the other with soil from a plot planted to corn for five years in succession without being dressed during that time with either manure or fertilizers.

Before publishing any results of these experiments with natural soils, we desire to repeat them with improvements suggested by recent experience and hope to make some report of them a year or two hence.

The Apparatus and Method.

These have been fully described in our Report for 1894, page 74, and in all points not specially noted in the following pages the same apparatus and method were employed in both years.

Vegetation Experiments in Artificial Soil. 1895.

A. Oat Crop.

These include those pots used in 1894, numbered from 5 to 21, 23 to 27, 102 to 117, 123 to 130, 135 to 137, 142 to 147. (See pages 83 to 86, Report of 1894.)

Soil and Fertilizers.—The pots, after the harvest in 1894, stood in a very dry cellar through the winter.

Just before planting time in the spring of 1895 the soil, consisting of coal ashes and peat with the roots of the crop of 1894, was poured out of each pot, such roots as had not decayed were pulverized and mixed with the soil, and after incorporating the fertilizers also with the soil, the whole was filled into the pot on the layer of gravel as described on page 78, Report of 1894.

Each pot received 5 grams of phosphate of potash, .25 gram of sodium chloride, .5 gram of sulphate of magnesia and 16 grams of carbonate of lime. The phosphate of potash contained 49.27 per cent. of potash and 35.82 per cent. of phosphoric acid, so that in 1895 each pot acquired 2.46 grams of potash and 1.79 grams of phosphoric acid. This, in addition to the amount of

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these ingredients left in the soil from the application made in 1894, could hardly have failed to provide both potash and phosphoric acid in excess of the crop requirements, for the largest crops harvested in 1895, from pots 12 and 13, took but .56 and .60 grams of phosphoric acid and 2.18 and 2.20 grams of potash respectively, from the soil.

The nitrogenous matters used in these experiments were the following:

Commercial Nitrate of Soda, slightly dried to facilitate grinding and weighing and containing 16.15 per cent. of nitrogen. This was a part of the same preparation which was used in 1894.

Dried Blood, bought from a dealer in fertilizers, which contained 11.4 per cent. nitrogen.

Castor Pomace, No. **4546,** a ground residue left after the removal of oil from the castor bean (*Ricinus*). The sample contained 4.98 per cent. of nitrogen.

Castor Pomace, No. **4545,** another sample, containing 4.78 per cent. of nitrogen.

Cotton Seed Meal. Bright yellow meal from the Connecticut market, containing 8.39 per cent. of nitrogen.

Dry Ground Fish, containing 9.51 per cent of nitrogen.

Ground Horn and Hoof from Chicago. Said to be made from horns and hoofs steamed under high pressure, which renders them brittle and easily reducible to a fine powder. The sample contained 15.59 per cent. of nitrogen and is part of the same preparation which was used in 1894.

"Bone Tankage," bought in New Haven, which contained 5.10 per cent. of nitrogen.

Linseed Meal, used extensively in this State as a cattle food but also, among tobacco growers, as a fertilizer. It contained 6.48 per cent. of nitrogen.

Raw Leather, **4581,** Steamed Leather, **4622,** Roasted Leather, **4623,** and Dissolved Leather, **4625,** have already been described on page 20 of the present Report.

All of the above materials were pulverized to pass circular holes $\frac{1}{60}$ inch in diameter.

The arrangement of the series of tests and the quantities of nitrogen used in them are shown in Table I, p. 105.

Before planting, the pots received the maximum quantity of water which was to be supplied to them during the test, together with the soil-infusion already spoken of.

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Seed and Planting.—From a large quantity of seed oats, kernels were selected which weighed between .03 and .04 gram each. After they had sprouted, 10 kernels were planted in each pot.

To do this, 650 grams (one pound and seven ounces) of soil were removed from the pot, the kernels were placed at regular distances apart on the surface thus prepared and the removed soil was replaced, covering the seeds to a depth of about one inch. The ten kernels contained .0066 grams of nitrogen.

The planting was done on the 22d, 23d, and 24th of April.

On the 26th the oats began to come up.

Care during Growth.—After planting, the pots were removed to the summer vegetation house described in our last Report.

The water supply was kept between 80 and 60 per cent. of the water-holding capacity of the soil (see foot-note page 108) by the means fully described in the last Report, page 87.

Soon after the plants had developed a single leaf, a number of them became unhealthy, but only in those pots which received the larger quantities of organic nitrogenous matters. The soil in some of these pots acquired a musty smell.

Plants supplied with quickly available organic nitrogen, dried blood, for instance, were more sickly in appearance than those supplied with tankage or roasted leather. Plants in the pots having 2.4 grams of nitrate-nitrogen were perfectly healthy and dark green, while those having the same quantity of blood-nitrogen were yellow and sickly.

Plants having .8 gram of blood-nitrogen were thrifty in appearance, those having double that quantity had paler leaves, those with three times that quantity were very sickly.

The plants with the smaller quantities of nitrogen recovered and made good growth and all fruited well, those with the larger quantities remained backward and sickly and in some cases died.

It appeared quite certain that the rapid decay within the soil of such large quantities of nitrogenous matter had injured or poisoned the growing plants.

No such effect had been anticipated because, in 1894, the same *kinds and quantities* of nitrogen had been used with the same soil and pots, and the maize crop grown in them was healthy through the season. Oats thus appear to be more susceptible to injuries from such decaying matters than maize.

Harvesting.—On July 9th the crops were separately cut, air-dried, and weighed. Determinations of moisture and of nitrogen

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were made in the air-dry crops. These figures are presented and discussed on subsequent pages.

B. Maize Crop.

The pots from which the oat crops had been cut were afterward planted to maize, without the addition of any fertilizer and without disturbing the soil.

Three selected kernels of Early Canada Corn, each weighing between .40 and .44 gram, and containing in the aggregate about .0067 gram nitrogen, were soaked in water until the swelling radicles were perceptible under the seed coats but had not broken through, and planted in each pot.

Holes an inch and a half deep were made in the soil with a peg, in each hole a kernel was placed and the soil pressed together over it.

The planting was done on July 24th. On the 28th most of the plants were up. The crops grew satisfactorily and appeared healthy until the nitrogen supply in the soil gave out. In those pots where the oat crop had been a failure on account of the poisoning of the plants by the rapidly decomposing organic matter, the maize crop was thriftiest and largest, because in these the oat crop had taken off but little of the nitrogen.

The maize crops were harvested on October 3, 1895.

In Table I are given the weights of the separate crops and of the nitrogen in them. A discussion of the results follows.

The following explanations are referred to by small numerals in their appropriate places in the table:

2. .8 gram at planting time, .8 gram later.

3. .8 gram at planting time and same quantity at each of two intervals during growth.

4. The water in the pot was kept between 80 and 60 per cent. of the water-holding capacity of the soil.

5. The water in the pot was kept between 70 and 50 per cent. of the water-holding capacity of the soil.

6. The water in the pot was kept between 60 and 40 per cent. of the water-holding capacity of the soil.

7. The water in the pot was kept between 80 and 40 per cent. of the water-holding capacity of the soil.

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TABLE I—VEGETATION EXPERIMENTS OF 1895. ARTIFICIAL SOIL.

Number of Pot.	Nitrogen supplied to the Oat Crop. In form of	Quantity of Nitrogen supplied. (Grams.)	Oat Crop. Weight of air-dry Crop, exclusive of roots (grms).	Oat Crop. Weight of Water-free Crop (grms).	Oat Crop. Per cent. of Nitrogen in the air-dry Crop.	Oat Crop. Total Nitrogen of Crop, exclusive of roots (grms).	Maize Crop (following the Oat Crop without additional fertilizer). Weight of air-dry Crop, exclusive of roots (grms).	Maize Crop (following the Oat Crop without additional fertilizer). Weight of Water-free Crop, exclusive of roots (grms).	Maize Crop (following the Oat Crop without additional fertilizer). Per cent. of Nitrogen in the air-dry Crop.	Maize Crop (following the Oat Crop without additional fertilizer). Total Nitrogen of Crop, exclusive of roots (grms).
5	Ground Horn and Hoof	.8	34.90	31.57	.87	.304	14.07	12.73	.57	.080
6	" " " "	1.6	64.60	57.65	.96	.620	25.13	22.87	.63	.158
7	" " " "	2.4	30.81	27.31	2.30	.709	60.14	54.25	.59	.355
8	" " " "	3.2	45.26	40.20	2.06	.932	76.18	68.90	.62	.472
9	Nitrate of Soda	.8	78.17	69.68	.83	.649	1.53	1.40	.58	.009
10	" "	1.6	87.94	76.86	1.40	1.231	10.29	9.24	.51	.053
11	" "	.8+.8[2]	84.88	73.55	1.44	1.222	9.05	8.04	.49	.043
12	" "	2.4	69.60	60.48	2.18	1.517	67.88	61.04	.70	.475
13	" "	.8+.8+.8[3]	88.27	77.09	2.00	1.765	64.96	58.35	.47	.305
14	Dried Blood	.8[4]	52.64	47.39	.95	.500	4.46	4.10	.69	.031
15	" "	1.6[4]	74.39	66.64	1.30	.967	11.76	10.99	.55	.065
16	" "	.8[5]	67.71	60.10	.60	.406	5.03	4.57	.63	.032
17	" "	1.6[5]	61.70	55.22	1.38	.852	19.56	17.89	.43	.084
18	" "	.8[6]	61.34	53.55	.80	.491	2.73	2.47	.91	.025
19	" "	1.6[6]	65.04	56.98	1.33	.865	12.40	11.36	.52	.064
20	" "	.8[7]	65.48	58.36	.80	.524	3.99	3.67	.71	.028
21	" "	1.6[7]	57.71	50.87	1.45	.837	23.76	21.70	.44	.105
23	" "	1.6	52.52	40.07	1.54	.809	17.84	16.35	.49	.087
24	" "	2.4	19 97	17.80	2.71	.541	99.83	90 65	.64	.639
25	" "	2.4	47.35	42.41	2.32	1.099	38.85	35.18	.49	.190
26	" "	3.2	10.11	8.87	2.98	.301	95.74	87.08	.87	.833
27	" "	3.2	5.66	5.06	3.03	.171	106.12	95.05	.92	.976
102	Castor Pomace No. 4545	.8	50.19	45.12	.94	.472	3.51	3.17	.68	.024
103	" " " "	1.6	48.44	43.52	1.71	.828	33.39	30.07	.42	.140
104	" " " "	2.4	50.83	45.49	2.37	1.205	47.29	42.96	.48	.227
105	" " " "	3.2	18.23	16.26	3.16	.576	130.94	118.43	.72	.943
106	Castor Pomace No. 4546	.8	58.85	53.01	.84	.494	2.83	2.58	.57	.016
107	" " " "	1.6	63.43	57.17	1.29	.818	23.20	21.54	.48	.113
108	" " " "	2.4	59.02	53.23	1.94	1.145	41.37	37.65	.49	.203
109	" " " "	3.2	.50	.45	....	....	144.34	130.17	.70	1.010
110	Cotton Seed Meal	.8	52.12	46.40	.88	.459	8.87	8.13	.61	.054
111	" " "	1.6	49.91	44.53	1.59	.794	28.34	25.89	.47	.133
112	" " "	2.4	42.35	37.76	2.34	.991	63.40	57.55	.38	.241
113	" " "	3.2	18.07	16.30	3.13	.566	117.53	106.91	.47	.552
114	Dry Fish	.8	56.63	51.10	.71	.402	3.62	3.34	.58	.021
115	" "	1.6	59.58	53.06	1.40	.834	14.18	13.02	.50	.071
116	" "	2.4	19.45	17.05	2.66	.517	79.91	72.61	.43	.344
117	" "	3.2	.24	.21	....	....	156 90	144.58	.63	.988
123	Tankage	.8	46.11	41.49	.73	.337	3.62	3.34	.63	.023
124	"	1.6	79.22	71.44	.70	.554	8.59	7.92	.62	.053
125	"	2.4	98.43	88.44	1.02	1.004	21.37	19.46	.46	.098
126	"	3.2	107.20	94.52	1.24	1.329	38.50	34.99	.45	.173
127	Linseed Meal	.8	47.02	42.17	.84	.395	7.49	6.83	.59	.044
128	" "	1.6	61.56	55.11	1.38	.850	29.78	27.17	.46	.137
129	" "	2.4	67.95	60.53	1.65	1.121	37.55	33.95	.45	.169
130	" "	3.2	6.20	5.53	2.84	.176	132.93	121.07	.57	.758
135	Raw Leather	.8	1.12	1.00	.82	.009	1.99	1.83	.57	.011
136	" "	1.6	1.10	.99	....	....	1.84	1.69	.59	.011
137	Dissolved Leather	.8	27.49	24.80	1.34	.368	5.61	5.09	.71	.040
142	Steamed Leather	.8	11.27	10.20	.59	.067	2.48	2.29	.55	.014
143	" "	1.6	17.84	16.00	.66	.118	3.09	2.83	.57	.018
144	" "	2.4	25.11	22.77	.68	.171	6.50	5.92	.53	.034
145	" "	3.2	31.93	28.80	.72	.230	6.77	6.13	.55	.037
146	Roasted Leather	.8	5.18	4.69	.90	.047	2.46	2.26	.63	.015
147	" "	1.6	12.15	10.91	.88	.107	5.23	4.76	.53	.028

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TABLE II.—VEGETATION EXPERIMENTS OF 1894 AND 1895. ARTIFICIAL SOIL. ONE CROP (MAIZE) IN 1894, TWO CROPS (OATS FOLLOWED BY MAIZE) IN 1895.

AVAILABILITY OF NITROGEN FROM DIFFERENT RAW MATERIALS.

Number of Pot.	Source of the Fertilizer-Nitrogen.	Crop raised.	Year.	Quantity of Fertilizer-Nitrogen (grams).	Quantity of Crop-Nitrogen (grams).	Crop-Nitrogen expressed in per cent. of Fertilizer-Nitrogen.	Yearly average from Figures of preceding column.	Corrected yearly average excluding Figures in brackets.	Corrected average for the two years.
5	Horn and Hoof	Maize.	1894	.8	.307	38.4			
6	" " "	"	"	1.6	.561	35.1			
7	" " "	"	"	2.4	1.015	42.3	38.9	38.9	
8	" " "	"	"	3.2	1.278	39.9			
5	" " "	Oats and Maize.	1895	8	.384	48.0			43.5
6	" " "	" " "	"	1.6	.778	48.6			
7	" " "	" " "	"	2.4	1.064	44.3	46.2	46.2	
8	" " "	" " "	"	3.2	1.404	43.9			
9	Nitrate of Soda	Maize.	1894	.8	.384	48.0			
10	" "	"	"	1.6	.867	54.2			
11	" "	"	"	.8+.8	.797	49.8	54.6	54.6	
12	" "	"	"	2.4	1.376	57.3			
13	" "	"	"	.8+.8+.8	1.531	63.8			68.4
9	" "	Oats and Maize.	1895	.8	.658	82.2			
10	" "	" " "	"	1.6	1.284	80.2			
11	" "	" " "	"	.8+.8	1.265	79.1	82.2	82.2	
12	" "	" " "	"	2.4	1.992	83.0			
13	" "	" " "	"	.8+.8+.8	2.070	86.3			
22	Dried Blood	Maize.	1894	.8	.334	[41.8]			
23	" "	"	"	1.6	.604	37.7			
24	" "	"	"	2.4	.931	38.8			
25	" "	"	"	2.4	1.030	42.9	40.1	39.8	
26	" "	"	"	3.2	1.287	[40.2]			
27	" "	"	"	3.2	1.261	[39.4]			
22	" "	----	1895	----	---	----			46.3
23	" "	Oats and Maize.	"	1.6	.896	56.0			
24	" "	" " "	"	2.4	1.180	49.1			
25	" "	" " "	"	2.4	1.289	53.1	46.0	52.9	
26	" "	" " "	"	3 2	1.134	[35.4]			
27	" "	" " "	"	3.2	1.147	[35.9]			
102	Castor Pomace No. 4545	Maize.	1894	.8	.351	43.9			
103	" " "	"	"	1.6	.680	42.5			
104	" " "	"	"	2.4	1.211	50.4	45.9	45.6	
105	" " "	"	"	3.2	1.499	[46.8]			
102	" " "	Oats and Maize.	1895	.8	.496	62.0			53.1
103	" " "	" " "	"	1.6	.968	60.5			
104	" " "	" " "	"	2.4	1.432	59.7	57.4	60.7	
105	" " "	" " "	"	3.2	1.519	[47.5]			
106	Castor Pomace No. 4546	Maize.	1894	.8	.315	39.4			
107	" " "	"	"	1.6	.505	31.6			
108	" " "	"	"	2.4	.945	39.4	36.6	36.8	
109	" " "	"	"	3.2	1.148	[35.9]			
106	" " "	Oats and Maize.	1895	.8	.510	63.5			48.0
107	" " "	" " "	"	1.6	.931	58.2			
108	" " "	" " "	"	2.4	1.348	56.2	52.4	59.3	
109	" " "	" " "	"	3.2	1.010	[31.6]			

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TABLE II.—VEGETATION EXPERIMENTS OF 1894 AND 1895. ARTIFICIAL SOIL. ONE CROP (MAIZE) IN 1894, TWO CROPS (OATS FOLLOWED BY MAIZE) IN 1895.—*Continued.*

AVAILABILITY OF NITROGEN FROM DIFFERENT RAW MATERIALS.

Number of Pot.	Source of the Fertilizer-Nitrogen.	Crop raised.	Year.	Quantity of Fertilizer-Nitrogen (grams).	Quantity of Crop-Nitrogen (grams).	Crop-Nitrogen expressed in per cent. of Fertilizer-Nitrogen.	Yearly average from Figures of preceding column.	Corrected yearly average excluding Figures in brackets.	Corrected average for the two years.
110	Cotton Seed Meal	Maize.	1894	.8	.330	41.3			
111	" " "	"	"	1.6	.589	36.8	40.3	41.6	
112	" " "	"	"	2·4	1.126	46.9			
113	" " "	"	"	3.2	1.157	[36.1]			49.7
110	" " "	Oats and Maize.	1895	.8	.513	64.1			
111	" " "	" "	"	1.6	.927	57.9	52.1	57.8	
112	" " "	" "	"	2.4	1.232	51.3			
113	" " "	" "	"	3.2	1.118	[35.0]			
114	Dry Fish	Maize.	1894	.8	.297	37.1			
115	" "	"	"	1.6	.531	33.2	35.5	35.2	
116	" "	"	"	2 4	.929	[38.7]			
117	" "	"	"	3.2	1.062	[33.2]			45.0
114	" "	Oats and Maize.	1895	.8	.423	52.9			
115	" "	" "	"	1.6	.905	56.6	44.0	54.8	
116	" "	" "	"	2.4	.861	[35.8]			
117	" "	" "	"	3 2	.988	[30.9]			
123	Tankage	Maize.	1894	.8	.282	35.3			
124	"	"	"	1.6	.590	36.9	37.2	37.2	
125	"	"	"	2.4	1.024	42.7			
126	"	"	"	3.2	1.077	33.7			40.5
123	"	Oats and Maize.	1895	.8	.360	45.0			
124	"	" "	"	1.6	.607	37.9	43.9	43.9	
125	"	" "	"	2.4	1.102	45.9			
126	"	" "	"	3.2	1.502	46.9			
127	Linseed Meal	Maize.	1894	.8	.330	41.2			
128	" "	"	"	1.6	.635	39.7	35.2	37.5	
129	" "	"	"	2.4	.755	31.5			
130	" "	"	"	3.2	.909	[28.4]			47.1
127	" "	Oats and Maize.	1895	.8	.439	54.9			
128	" "	" "	"	1.6	.987	61.7	49.9	56.8	
129	" "	" "	"	2.4	1.290	53.8			
130	" "	" "	"	3.2	.934	[29.9]			
135	Raw Leather	Maize.	1894	.8	.014	1.8			
136	" "	"	"	1.6	.009	.5	1.1	1.1	1.4
135	" "	Oats and Maize.	1895	.8	.020	2.5			
136	" "	" "	"	1.6	.011	.7	1.6	1.6	
137	Dissolved Leather	Maize.	1894	.8	.308	38.5	38.5	38.5	44.7
137	" "	Oats and Maize	1895	.8	.408	51.0	51.0	51.0	
142	Steamed Leather	Maize.	1894	.8	.047	5.9			
143	" "	"	"	1.6	.053	3.3			
144	" "	"	"	2.4	.088	3.7	4.1	4.1	
145	" "	"	"	3.2	.116	3.6			
142	" "	Oats and Maize.	1895	.8	.081	10.1			6.5
143	" "	" "	"	1.6	.136	8.5			
144	" "	" "	"	2.4	.205	8.5	8.8	8.8	
145	" "	" "	"	3.2	.267	8.3			
146	Roasted Leather	Maize.	1894	.8	.040	5.0			
147	" "	"	"	1.6	.011	4.4	4.7	4.7	
146	" "	Oats and Maize.	1895	.8	.062	7.8			6.5
147	" "	" "	"	1.6	.135	8.5	8.2	8.2	

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Determination of Nitrogen in the Oat Crops.

Presence of Nitrates.

Many of the crops contained nitrates, and some of them very considerable quantities. The Jodlbauer-Kjeldahl method was therefore used in all cases for determining nitrogen.

Direct determinations of nitrate-nitrogen in some of the air-dry crops gave the subjoined results :

Pot No.	In air-dry crops Nitrogen as Nitrates.
5	Not more than .05 per cent.
6	" " " .05 "
7	.56 "
8	.44 "
13	.46 "
24	1.00 "
25	.50 "
104	.65 "
129	Not more than .12 "

It is well known that when nitrates are abundant in the soil they often enter plants more rapidly than they can be assimilated, and sometimes accumulate in large amount. Striking instances are to be found in Annual Report of this Station for 1888, p. 62, and especially in Kansas Exp. St. Bulletin No. 49.

The nitrate nitrogen, no less than the organic nitrogen, found in the crops under notice, we must assume to have been furnished by the fertilizers that were used and therefore should be credited to these fertilizers.*

Discussion of Tables I and II.

The Water Supply.

Four pairs of pots, fertilized with Dried Blood, were watered differently for the purpose of observing the most suitable proportions of water to provide in these experiments.

In pots 14 and 15, Table I, the water in the soil was maintained between 80 and 60 per cent. of the water-holding capacity of the soil;† in pots 16 and 17 between 70 and 50 per cent.; in pots 18

* Various evidence has indeed been adduced of late years, going to show that fungoid vegetation or microbes are able to assimilate free atmospheric nitrogen, but our knowledge of the extent and conditions of this alleged assimilation is as yet too uncertain to warrant introducing this possibility into our discussion.

† The quantity of water which the perfectly saturated soil in a vegetation pot holds, measures the "water-holding capacity" of this soil. In these experiments this quantity of water was 3892 grams or 8.57 pounds. 80 per cent. of this is 3113 grams, or 110 ounces.

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and 19 between 60 and 40 per cent., and in pots 20 and 21 betweeen 80 and 40 per cent.

In other pots, the water supply was maintained between 80 and 60 per cent., but was to be changed at any time, if the growth in either series of pots 14 to 19, appeared better. The results show that in 1895, as in 1894, the largest assimilation of nitrogen was in pots where the soil had a water content of 80 to 60 per cent., the amount used in all the other series.

Availability of the Fertilizer-Nitrogen.

Our own experiments illustrate what has been abundantly demonstrated by others, that the weight of *dry matter* harvested (water-free crop) is no certain measure of the nitrogen assimilated by the crop.

The different crops vary greatly in the per cent. of nitrogen which they contain, or otherwise expressed, an ounce of nitrogen taken by the crop in one case causes a much larger production of dry matter than in another, particularly if other factors which control growth are not alike.

To illustrate: Pots 5, 6, 7 and 8, Table I, page 105, received .8, 1.6, 2.4 and 3.2 grams of nitrogen* respectively, in form of horn and hoof. As none of these quantities was excessive, and the other fertilizer ingredients were present in abundance, it might be expected that the dry matter harvested from the two crops together, would show an increase somewhat corresponding to the increase of nitrogen. But they do not.

The dry matter of the crops is 31.7, 57.8, 27.7 and 40.7.† From this it appears that 0.8 gram of fertilizer nitrogen produced more dry matter than 2.4 grams, and 1.6 grams of fertilizer nitrogen produced more than 3.2 grams. These figures *in themselves* would be puzzling and worthless.

But, the determination of the nitrogen actually taken up by the crops from the fertilizer, makes the results intelligible. The

* The Fertilizer-nitrogen ratios are 10, 20, 30, 40.

† The Dry Crop ratios are 10, 18, 9, 13.

‡ The Crop-nitrogen ratios are 10, 20, 28, 36¼.

In 1894 there was a much closer correspondence among ratios of the same order, viz:

In 1894 the Fertilizer-nitrogen ratios were, 10, 20, 30, 40
" " Dry Crop " 10, 16, 18, 19
" " Crop-nitrogen " 10, 18, 33, 41.

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quantities are .384, .778, 1.064 and 1.404 respectively,‡ being a regular increase of nitrogen assimilated, corresponding to the increase in nitrogen supplied. This increase is not necessarily proportional to the increase of nitrogen supplied, for as the quantity of nitrogen in the fertilizer approaches the greatest amount which the plants can utilize, the increase of crop-nitrogen with each successive increase of fertilizer-nitrogen must grow less and less, till there comes a point where increase of fertilizer-nitrogen gives no increase of crop-nitrogen.

In considering the relative availability of the different forms of nitrogen, as shown by these tests, we shall notice, therefore, only the quantities of nitrogen which the crops took from the fertilizer supplied to them.

It is seen that the unequal development and unhealthy condition of the oat plants in the pots having the larger doses of quickly decomposing organic fertilizers, renders any conclusions from the oat crop alone unsatisfactory.

The maize crop of 1895 was also very irregular, but in all cases where the oat crop failed, or was small, the following maize gave a large yield: Nos. 26, 27, 105, 109, 113, 117 and 130. It is likewise to be remarked that the large oat crops, in every instance, were followed by small (and usually the largest by the smallest) maize crops. This fact indicates that the final maize crops probably almost or completely exhausted the nitrogen available at the termination of the experiment. Therefore, a comparison of the fertilizer-nitrogen supplied in the two applications of 1894 and 1895 with the crop-nitrogen obtained in the three harvests of those years, will probably furnish a trustworthy estimate of both the absolute and relative availability of the fertilizer-nitrogen.

Table II gives a complete view of all the results of 1895 and of 1894, which are fairly comparable. The last columns give the averages based upon these data.

A considerable number of experiments made with Dried Blood as a source of nitrogen, to study the effects of increased or diminished supply of water, potash or phosphoric acid, are excluded from Table II, because they are not strictly comparable with the others in a discussion of the availability of different forms of nitrogen. Most of them, however, gave the same result as that stated in Table II for the six pots there included.

Certain exceptional results, which in Table II are enclosed in brackets, are excluded from the "corrected averages."

‡ See foot-note on p. 109.

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The crop-nitrogen in both pots 26 and 27, which received 3.2 grams of nitrogen in Dried Blood, was less than in pots 24 and 25, which received only three-fourths as much nitrogen. This is explained by the fact already mentioned on page 103, viz: that the oat crop was seriously damaged by the rapid decay of the nitrogenous matter within the soil. A portion of the nitrogen of the decaying matter was possibly set free or made inaccessible to the following maize crop. These two results should, therefore, be excluded from the final average.

Since the crop-nitrogen expressed in per cent. of the fertilizer-nitrogen (which in this paper we shall call the "per cent. availability" or "per cent." simply), was much larger in 1895 than in 1894, we must exclude the corresponding experiments in 1894 (pots 28 and 27) from a general average of the results of both years, in order to give the results in 1895 and 1894 their true relative value in the average.

The same remarks apply to the crops in pots 105, Castor Pomace No. **4545**; 113, Cotton Seed Meal; 116, Dry Fish; and 130, Linseed Meal.

While the crop-nitrogen in pot 117 is larger than in 116 or 115, it bears no just proportion to the increase of fertilizer-nitrogen, the oat crop in this pot being almost a total failure.

The results in the instances cited have been accordingly excluded from the last two columns of averages.

In the column headed "Crop-nitrogen expressed in per cent. of fertilizer-nitrogen" (Table II), we have a set of figures obtained, in the first instance (pot 5), by the arithmetical proportion .8 : 100 : : .307 : 38.4, which signifies that of 100 parts of fertilizer-nitrogen, in this case supplied by horn and hoof, 38.4 parts have been taken into the crop which was harvested from that pot.

The "crop" here, be it remembered, does not include roots.

The column headed, "Yearly average from figures of preceding column," gives the average of *all* the figures from the preceding column, *including those inclosed in brackets.*

For reasons just mentioned, the figures in brackets are excluded from the final averages, which are stated in the last two columns. It will be noticed that the greatest difference between the mean of the "yearly averages" and that of the "corrected yearly averages" occurs in case of Dry Fish, and there amounts to 5.3 per cent. The other differences are for Linseed Meal, 4.6 per cent.;

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Cotton Seed Meal and Castor Pomace No. **4546**, each 3.5 per cent.; Dried Blood, 3.3 per cent.; and Castor Pomace No. **4545**, 1.5 per cent.

It is thus plain that the disaster to the Oat Crop and the consequent irregularities in the growth of the following maize crop have very nearly compensated each other in respect to the total acquisition of fertilizer-nitrogen.

In the following statements the various fertilizers are arranged in the order of their efficiency (expressed in round numbers) as sources of nitrogen to the maize and oat crops in our experiments of 1894 and 1895.

	Per cent. of available Nitrogen reckoned on total Nitrogen.	Per cent. of available Nitrogen reckoned on the available Nitrogen of Nitrate of Soda.
Nitrate of Soda	68	100
Castor Pomace No. **4545**	53	77
Average of Castor Pomace Nos. **4545** and **4546**	50.5	74
Cotton Seed Meal	49.5	72
Castor Pomace No. **4546**	48	70
Linseed Meal	47	69
Dried Blood	46.5	68
Dry Fish	45	66
Dissolved Leather	44.5	64
Horn and Hoof	42.5	62
Tankage	40.5	59
Steamed Leather	6.5	9
Roasted Leather	6.5	9
Raw Leather	1.5	2

Since in all cases the roots of the plants remained in the soil and we have no ready means of learning how much nitrogen the roots contain, our experiments show only what the "crops," i. e., the cropped stems, leaves and fruit, have taken up and not what the vegetation as a whole has made use of.

As is well known, the roots of many plants make at first a relatively greater growth than the tops, and in the flowering and fruiting processes there is an extensive and rapid transfer of vegetable substance from the roots to the tops.*

* The quantity of roots in per cent. of the entire plant in the dry state, was found by Schubart to be as follows:

Winter wheat, last of April	40 per cent.
" " May	22 "
Peas, four weeks after sowing	44 "
" at time of blossom	24 "

—How Crops Grow, p. 264.

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This is one reason why the increase of crop-nitrogen does not keep regular pace with the increase of fertilizer-nitrogen. That the increase of crop-nitrogen is not always parallel with that of dry substance, probably depends in part on the fact that in different stages, or under different conditions of growth, the proportion of nitrogen in the roots is now greater and now smaller than in the tops.

Looking now at the item Nitrate of Soda, we find that of 100 parts of its nitrogen applied as a fertilizer, 68½ parts were recovered in the three crops. There remains of course in the soil a residue of nitrogen in the form of maize roots, but since the nitrogen of all the last maize crops was less than one-sixth that of the oat crops, we may infer that the available residue is not large.

The strikingly greater availability of nitrate nitrogen in 1895, 82 per cent., over that found in 1894, 55 per cent., is evidently in part due to the fact that while the first maize crops practically had no source of nitrogen except the nitrate, each of the second year's crops had, besides the nitrate applied directly to the oats, some residue of the first year's supply, perhaps unused nitrate and certainly nitrogen of the roots of the first year's crop, which became available the second year.

Another reason of the larger availability shown in the second year lies in the fact that the soil then bore two crops and was more than twice as long in possession of active vegetation. The maize crop of 1894 occupied the pots 68 days. The oat crop of 1895 was 75 days and the maize crop of that year 68 days (on the average) between seeding and harvest.

We observe, in Table II, that, in general, the availability of nitrate nitrogen increased somewhat, as the quantity used was greater. In 1894 the increase was large, rising from 48 to 64. In 1895 it was slight, rising from 74 to 79. In both years, however, pot 11 yielded less than pot 10, apparently because the small applications, which were the same in total amount, were better utilized, when applied at once, than when given in two doses. In pot 10 the 1.6 gram of nitrogen would seem to have given the young plants a better start, developed a stronger root system and enabled the plants to forage more effectually.

On the other hand, 13 surpassed 12 both years, three applications of 0.8 gram each, giving slightly greater yield, than one of 2.4 grams.

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The oat crops supplied with nitrate had a healthy appearance throughout the season. At harvest the nitrate oat crops averaged from 42 to 48 inches in height, each pot bore from 23 to 38 stalks, an average of 30, of which 26 were headed.

Castor Pomace No. **4545** stands second in order of nitrogen-availability. Of 100 parts of nitrogen, supplied in this form, the crops in two years assimilated 53 parts.

Crops 102, 103, 104 while evidently injured at the outset as already described, had a fair color and growth on June 19, while crop 105, which as early as May 9th was inferior to the others, on June 19th was stunted and yellow and had but three plants (bearing 17 stalks) remaining. These were green and still growing at harvest. Crop 105 is excluded from the average.

The other crops had 14, 20 and 30 stalks, bearing 14, 17 and 17 heads respectively, and were from 45 to 48 inches high.

Next in order of nitrogen-availability stands Cotton Seed Meal, 49.5.

While all the crops in this series were yellow in color at first, 110 recovered, made good growth and had a dark green color by June 5. 111 and 112 were longer in recovering, but made fair growth later, while 113 was stunted and pale in color through the season, and has been excluded from the average. The number of stalks in the several crops was 15, 32, 27, 14; the number of heads, 15, 20, 15, 3. Crop 110, which had least nitrogen, was the tallest, 47 inches; the others were 40, 38 and 27 inches.

It is seen that for 1895 the nitrogen-availability was greatest in crop 110, and diminishes regularly and rapidly in the three other crops. We believe that this was caused by damage to the oat crops, which was not, as in other cases, fully compensated by the increase in following maize crop. If this be true, the relative availability of the nitrogen of Cotton Seed Meal is somewhat greater than shown by our results.

Castor Pomace, No. **4546**, has an availability of 48. Crop 106 had a healthy appearance and growth through the season. Crops 107 and 108, which were sickly at first, recovered early in June and made fair growth. Crop 109 was unthrifty and stunted from the outset and at last died completely. It is excluded from the average.

The other crops bore 13, 18 and 25 stalks respectively, with 13, 15 and 19 heads. The heights were 42, 45 and 36 inches respectively.

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The experiments of the two years indicate a decided superiority of the Castor Pomace No. **4545.**

Whether the inferiority of the Castor Pomace No. **4546** is due to presence of more oil or to greater heat used in preparation whereby the albuminoids have been more thoroughly coagulated or more hardened by drying, is not at present known.

Scarcely less than the availability of this kind of Castor Pomace is that of Linseed Meal, 47, and Dried Blood, 46.5.

The oat crops in both series were badly injured at the start; crop 130 which received Linseed Meal and crops 26 and 27 which received Dried Blood remained stunted and sickly through the season, and were excluded from the average. The oat crops raised with Dried Blood had 21, 16, 26, 18 and 10 stalks of 45, 35, 44, 24 and 22 inches in length, and with 19, 7, 14, 8 and 3 heads respectively; those raised with Linseed Meal had 15, 29, 33 and 9 stalks of 50, 48, 42 and 26 inches length, and with 14, 21, 23 and 3 heads.

Dried Fish had an availability of 45. Only two crops, 114 and 115, are considered in making this average, because of the damage sustained by the oat crops in the other pots early in the season.

Dissolved Leather, Horn and Hoof, and Tankage follow, with availabilities of 44.5, 42.5 and 40.5 respectively.

The method of preparing the Dissolved Leather has been already described on page 20 of this report.

The Leather was heated with about one and a half times its weight of oil of vitriol in a manner that probably has not been attempted on a commercial scale. Crops 137 demonstrated that the nitrogen of Leather can be made as available to plants as is that of Dry Fish, Blood or Tankage.

It will be noticed that in these experiments Tankage has shown a lower availability than any other of the approved forms of fertilizer-nitrogen, and that Fish and Horn and Hoof have a lower availability than Blood, or the vegetable forms of organic nitrogen. Their solubility in pepsin-solution as observed in last year's Annual Report follows the same order as their nitrogen-availability here recorded.

Steamed or Roasted Leather is a slowly acting fertilizer, but in these experiments, its nitrogen was nearly four to five times more available than that of Raw Leather, and was twice as available the second year as the first, a result doubtless due to the multiplication in the soil of the microbes that are essential to decay,

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whereby the nitrogen of leather is converted into forms that can feed vegetation.

In our last Report, 1894, p. 97, it was stated that "Extended discussion of these results is reserved till the tests have been repeated under varying conditions."

The experiments of 1895 just described do not by any means conclude the subject, but are rather a report of progress and have been purposely described so as to present fully their defects. The investigation will be continued during the coming season.

The indications of the present year's tests agree with those of 1894 in these respects, that the nitrogen of Castor Pomace No. 4545 has shown the highest availability of any form of organic nitrogen, that Fish, Horn and Hoof, and Tankage have manifested the lowest availability, Leather excepted. While Cotton Seed Meal, Castor Pomace No. 4546, Linseed Meal and Dried Blood stand intermediate, with no very striking difference between the four.

In conclusion we refer to the tabulated statements on page 112, as giving the results of our vegetation experiments during 1894 and 1895, on the actual and relative availability of Fertilizer-Nitrogen.

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THE COMPARATIVE EFFECTS OF MURIATE AND SULPHATE OF POTASH ON THE POTATO CROP.

By E. H. Jenkins.

The muriate is at present the cheapest source of potash, of which it contains 50 per cent., and costs at retail about $42.50 per ton, while the high grade sulphate, having also 50 per cent. of potash, costs from $50 to $55 per ton. The double sulphate of potash and magnesia, commonly called "low grade sulphate," selling for about $30 per ton, contains from 26 to 28 per cent. of potash, and is quite as expensive a source of potash as the high grade sulphate.

The muriate is, therefore, chiefly used, unless for special reasons.

German field experiments have shown, in many instances, that muriate of potash, on potato land, especially when applied in the spring, more or less increases the proportion of water and correspondingly diminishes the per cent. of starch and other solids in the crop of tubers. These effects are most marked when kainit (advertised as a sulphate but containing a large amount of muriates) is used as the source of potash.

Watery potatoes are well known to be inferior for cooking as well as for feeding purposes and, accordingly, it is often advised to apply sulphate of potash and to avoid using either the muriate of potash or kainit upon potato fields, although the yield of tubers is generally increased by the muriate of potash more than by the sulphate.

The only experiments made in this country bearing on this subject, report of which has come under our observation, are those made at the New Jersey Station.

The soils on which the tests were made were first, a heavy and gravelly clay loam, with clay subsoil, not specially adapted to potatoes; second, a fertile sandy loam, with open subsoil, well suited to potatoes; and third, a light sandy loam, of medium fertility. Each plot received 200 lbs. nitrate of soda, 320 lbs. dissolved bone black and 160 lbs. of either muriate or sulphate of potash or else 640 lbs. of kainit.

The results of the three series of tests were concordant and showed that the yield of tubers from muriate was four to six per cent. greater than from sulphate; that the tubers raised without

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fertilizer had the highest per cent. of dry matter; and that the average decrease of dry matter and of starch in the tubers, attributable to the different form of potash, were as follows:

	Decrease, per cent. Dry Matter.	Starch.
Sulphate of potash	3.1	4.3
Muriate of potash	7.1	7.7
Kainit	11.8	12.7

The potatoes raised with sulphate of potash, while not so large, were more uniform in size and had a smoother skin than the others. Samples of the three sorts were cooked alike and persons unacquainted with their origin, selected without hesitation, as the best, those grown with sulphate.

Four similar field-tests made under the supervision of this Station, are described in the following pages.

Experiment on Land of Mr. G. F. Platt, Milford, Ct.

The field is situated on the second terrace of the bank of a small stream, and the soil is light and gravelly. The trial was made in 1888. Over the whole field had been broadcast, at the rate of 1000 lbs. per acre, a home mixture containing 4.8 per cent. of nitrogen, 10.5 per cent. of phosphoric acid and 8.5 per cent. of potash in form of mixed sulphate and muriate of potash (163 lbs. of high grade sulphate of potash and 120 lbs. of muriate per ton of fertilizer).

There were sown in addition, on one measured acre, 200 lbs. of muriate of potash, and on another acre 200 lbs. of high grade sulphate of potash (51 per cent. actual potash). "Beauty of Hebron" potatoes, medium size tubers, were planted whole about the 15th of May. All of the acre plots had precisely the same cultivation and care. During growth no striking differences were noted, except that in the last week of July the tops on the muriate plot looked a little yellow, as if more mature.

On September 9th the potatoes were dug and weighed by us and samples drawn for analysis.

The crop from every fifth row, making six rows on each acre, was weighed, and from these the acre-yield was calculated. The potatoes were almost entirely free from rot.

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Following are the yields per acre:

		Yield in bushels.	Per cent. of Starch in potatoes.	Pounds of Starch per acre.	Pounds of Starch per bushel of potatoes.
A	Home-mixture and muriate of potash	163¾	17.0	1675	10.2
B	Home-mixture and sulphate of potash	178	17.9	1909	10.7
C	Home-mixture alone	186¼	17.6	1971	10.6
D	No fertilizer	100⅝	18.1	1096	10.9

On D, without fertilizer, the potatoes were very inferior, not more than one-half of them marketable. If we call the yield of potatoes and of starch on the unfertilized plot 100 per cent. the other crops will stand as follows:

		Per cent. yield.	Starch.
A	Home-mixture and muriate	162	153
B	Home-mixture and sulphate	176	174
C	Home-mixture alone	185	180
D	No fertilizer	100	100

It appears that the addition of potash salts depressed the yield slightly, the sulphate less than the muriate, and that the yield of starch to the bushel of potatoes was largest with no fertilizer, next with sulphate of potash and with home-mixture, and least with muriate.

Evidently Mr. Platt's home-mixture contained all the potash that the crop required in this season and on this land.

Analyses of Potatoes raised by Mr. Theron E. Platt, of Newtown, Ct., in 1887.

Two samples of White Flower potatoes were sent to this Station by Mr. Platt for examination, with the statement that the one was raised with help of 200 lbs. of sulphate of potash per acre, the other represented the crop grown with 200 lbs. of muriate, the other fertilizers being alike.

Their specific gravities and per cent. composition were as follows:

	Potatoes raised with Sulphate of Potash.	Muriate of Potash.
Specific gravity	1.091	1.082
Water	76.77	77.39
Starch	18.38	17.99
Ash	.93	.98
Total nitrogen	.38	.35
Starch in the dry matter	79.10	79.60

In this case the potatoes raised with muriate contained .6 per cent. more water and .39 per cent. less starch than those raised with sulphate, but the DRY MATTER of the latter contained half a per cent. less of starch.

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EXPERIMENT CONDUCTED BY MR. W. H. OLCOTT, SOUTH MANCHESTER. 1895.

In connection with observations on the prevention of potato scab, described elsewhere in this Report, Mr. Olcott tested the comparative effects of sulphate and muriate of potash.

The soil of the experiment field is a very light sandy loam.

The field for ten years previous to 1894 had not been fertilized at all. In 1894 potatoes were grown with about the same kind of fertilizers as in 1895.

In 1895 the land received per acre 1500 pounds of a home-mixture, described on page 65 of this Report.

One of the plots had mixture **4876,** containing 120 pounds of potash as muriate, the other had mixture **4877,** containing the same quantity of potash as sulphate.

Samples of the crops raised with the two fertilizers contained per cent.

	Potatoes raised with Muriate of potash.	Potatoes raised with Sulphate of potash.
Water	78.29	77.83
Dry matter	21.71	22.17
Starch	14.14	14.34
Starch in the dry matter	65.10	64.70

The potatoes grown with muriate in this test contained nearly half a per cent. more water and correspondingly less starch than those raised with sulphate. The dry matter of the potatoes raised with muriate, however, contained more starch than those grown with sulphate by about .4 per cent.

EXPERIMENT CONDUCTED BY THE STATION ON LAND OF J. H. WEBB, HAMDEN, 1895.

The soil was a light sandy loam, in good condition as regards fertility.

The whole piece received a light dressing of stable manure, which was plowed in. It was then divided into four plots, each 410 by 27 feet and containing a quarter of an acre. One-half of each plot was dressed with oyster shell lime at the rate of 250 pounds per acre.

Each plot received in the drill 120 pounds of dissolved bone black (containing 20 pounds of phosphoric acid) and 90 pounds of dried blood (containing 12 pounds of nitrogen).

Plot A received no potash. Plot B received 63 pounds of potash as muriate. Plot C the same quantity of potash in form

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of double sulphate of potash and magnesia, and plot D the same quantity of potash as high grade sulphate.

The field was planted to potatoes and cultivated and harvested in the usual way.

The yields were as follows :

POTATO EXPERIMENT ON LAND OF J. H. WEBB, SEASON OF 1895.

Plot.	Potash salt used.	Yield per ¼ acre in pounds. Salable.	Small.	Equivalent bushels per acre.	Water.	Starch in fresh Potatoes.	Starch in dry matter of potatoes.
A	No potash salt,	2610	432	202	79.55	15.47	75.72
A_1	Same as A, with lime,	3276	576	256	79.65	15.48	76.07
B	Muriate of Potash,	2646	666	221	79.25	15.63	75.41
B_1	Same as B, with lime,	2574	792	224	79.24	15.68	75.59
C	Double sulphate of potash	2808	369	212	79.42	15.63	75.93
C_1	Same as C, with lime,	2592	342	196	78.86	16.07	76.03
D	High grade sulphate of Potash,	3456	432	259	78.72	15.90	74.74
D_1	Same as D, with lime,	2772	486	217	78.42	16.55	76.69

The results show that the soil was not strikingly deficient in potash. The muriate increased the yield some 10 per cent., the high grade sulphate 29 per cent., the double sulphate 5 per cent., assuming that the plots at the outset were alike in crop-producing capacity.

Lime in connection with the potash salts in two out of the three tests reduced the yield.

The difference in composition of the tubers from the several plots was small.

The largest difference in water-content was 1.2 per cent. and in starch 1.1 per cent., and the greatest difference in starch content of the dry matter was 1.95 per cent.

Contrary to general experience, the potatoes grown without potash fertilizers had nearly as much water and less starch than any others.

Averaging the results of the limed and unlimed plots, the potatoes grown on muriate of potash contained 15.65 per cent. of starch, those grown with sulphate of potash 16.22 per cent. and those grown with double sulphate 15.85 per cent.

The percentages of starch in the dry-matter of the potato were 75.50, 75.70, and 75.98 respectively.

The per cents. of small and unsalable potatoes in the crops from the several plots were as follows:

No potash salt in fertilizer	14.6 per cent.
Muriate of potash used	21.8 "
High grade sulphate used	13.0 "
Double sulphate of potash	11.6 "

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EXPERIMENT CONDUCTED BY T. J. STROUD, OF SHAKER STATION, CONN.

This experiment was carried out by Mr. Stroud in coöperation with the German Kali Works, of New York. A representative of the Station was present at the harvest, and samples drawn at that time were examined in the Station laboratory.

The aim of the experiment was to learn how muriate of potash compares with sulphate of potash in its effects on both the yield and starch-content of the crop, and what is the effect of an application of lime with these salts of potash.

Incidentally Mr. Stroud also made a comparative test of wood ashes, Florida soft phosphate and a home-mixed "complete" fertilizer.

The field was an old pasture which had been top-dressed from time to time but had not been under the plow for many years.

The variety of potatoes was the New Queen.

The fertilizers used and the arrangement of the plots is shown in the table on page 124.

Mr. Stroud's notes regarding the care of the crop and the weather are as follows:

Culture.—The field was plowed on April 10th to 12th, harrowed twice with Cutaway and Acme harrows on May 3d and 4th and immediately plowed and harrowed a second time.

After marking out the plots of one-fifth acre each, the fertilizer was sowed on May 14th with the Spangler broadcast fertilizer distributor.

The next day the whole piece was planted with an Aspinwall planter.

On the 23d the lime was applied to certain plots and harrowed in.

On the 30th the piece was harrowed with the Thomas smoothing harrow.

June 3d, Breed's weeder was run over the plots. The next day the potato plants first appeared, having been kept back by the cold, dry weather.

On June 7th and again on the 13th, Breed's weeder was run over the plots, and on the 22d the Planet Jr. cultivator.

On June 25th, 29th and July 5th, Paris Green was put on with the machine sprinkler, and on June 31st it was applied with the Leggett gun.

June 27th. Used the Prout hoe on the plots.

July 28th and August 8th. Bordeaux mixture was put on with the machine sprinkler.

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The crop was harvested between the 17th and the 24th of September.

Weather.—The week from May 3d to 10th was dry and very hot but on the 14th and 17th there were frosts, and the weather continued cold and dry till the 24th. There were showers on that day and the next and heavy rain on the 26th.

From the 28th to June 1st the air temperature rose to 90° each day. Heavy rain fell for five hours on June 4th. There was rain on the 5th, 24th, 27th and 28th of June and on the 4th, 6th, 10th, 13th, 16th, 27th and 30th of July. The weather from then on was generally dry, with some very warm weather in the middle of September.

In July Mr. Stroud made a careful examination of the plots to note the comparative effects of blight and marked the general appearance of the vines on a scale of 100. His record is as follows:

APPEARANCE OF THE CROP IN JULY.

Plot.	Fertilizers.	Relative thriftiness of Vines. Perfect = 100.	
Plot 1.	No fertilizer	40	Tops fairly green, somewhat blighted.
" 1a.	Lime	45	Tops a little more blighted.
" 2.	Nitrate and Bone Black	60	" a little blighted.
" 2a.	Same as 2, with lime	55	" a little more blighted.
" 3.	Nitrate, Bone Black and muriate	80	" not much blighted.
" 3a.	Same as 3, with lime	90	" " "
" 4.	Nitrate, Bone Black and double quantity muriate	95	" " "
" 4a.	Same as 4, with lime	100	" only a trifle blighted.
" 5.	Nitrate, Bone Black and sulphate	90	" turning ripe a trifle.
" 5a.	Same as 5, with lime	80	" " a little more.
" 6.	Florida soft phosphate	55	" blighted a little.
" 6b.	Florida soft phosphate and nitrate	60	" " "
" 7.	Florida soft phosphate and muriate	65	" not much blighted.
" 7b.	Same as 7, with nitrate	75	" blighted a little.
" 8.	Home mixture	85	No blight.
" 9.	Nitrate and wood ashes	70	" "

The vines on plot 8, where organic nitrogen was used in the fertilizer, were green for nearly a month longer than those on plots which were dressed with nitrate of soda.

The potatoes were carefully dug by hand, sorted on the field, photographed and then weighed on a platform scale, the crop from each plot by itself, as they were hauled from the field.

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Photographs of the potatoes from some of the plots are reproduced in the accompanying plates.

The salable potatoes from each plot were sampled by the Station representative and water and starch were determined by Mr. Winton in each lot.

The results of the experiment appear in the following table:

POTATO EXPERIMENT, CONDUCTED BY MR. T. J. STROUD, SHAKER STATION, SEASON OF 1895.

No. of Plot.	Fertilizers Used.	Yield, (pounds) per Plot. Salable.	Small.	Total.	Equivalent Bushels per Acre.	Moisture, per cent.	Starch, per cent.	Per cent. of Starch in Water Free Substance.
1	No fertilizer	436	444	880	73	78.20	16.65	76.39
1a	400 lbs. lime	910	300	1210	101	78.27	16.58	76.32
2	80 lbs. nitrate of soda, 123 " acid phosphate	1370	318	1688	140	78.25	16.79	77.13
2a	80 lbs. nitrate of soda, 123 " acid phosphate, 400 " lime	1207	278	1485	124	78.48	16.51	76.73
3	80 lbs. nitrate of soda, 123 " acid phosphate, 24 " muriate of potash	2284	222	2506	209	79.01	16.22	77.27
3a	Same as plot 3, with addition of 400 lbs. lime	2386	304	2690	224	78.56	16.48	76.85
4	80 lbs. nitrate of soda, 123 " acid phosphate, 48 " muriate of potash	2415	450	2865	239	78.98	16.16	76.87
4a	Same as plot 4, with addition of 400 lbs. lime	2434	377	2811	234	79.23	15.44	74.31
5	80 lbs. nitrate of soda, 123 " acid phosphate, 24 " sulphate of potash	1914	446	2360	197	78.03	16.69	76.04
5a	Same as plot 5, with addition of 400 lbs. lime	1896	335	2231	186	78.56	16.16	75.18
6	90 lbs. Florida soft phosphate	942	278	1220	102	78.74	16.28	76.52
6b	80 lbs. nitrate of soda, 90 " Florida soft phosphate	1306	306	1612	134	78.95	15.57	73.99
7	24 lbs. muriate of potash, 90 " Florida soft phosphate	----	----	2034	170	----	----	----
7b	80 lbs. nitrate of soda, 90 " Florida soft phosphate, 24 " muriate of potash	----	----	2210	184	----	----	----
8	200 lbs. Home mixed fertilizer	2512	314	2826	235	78.63	16.47	77.10
9	80 lbs. nitrate of soda, 550 " wood ashes	1996	252	2248	187	78.76	16.19	76.23

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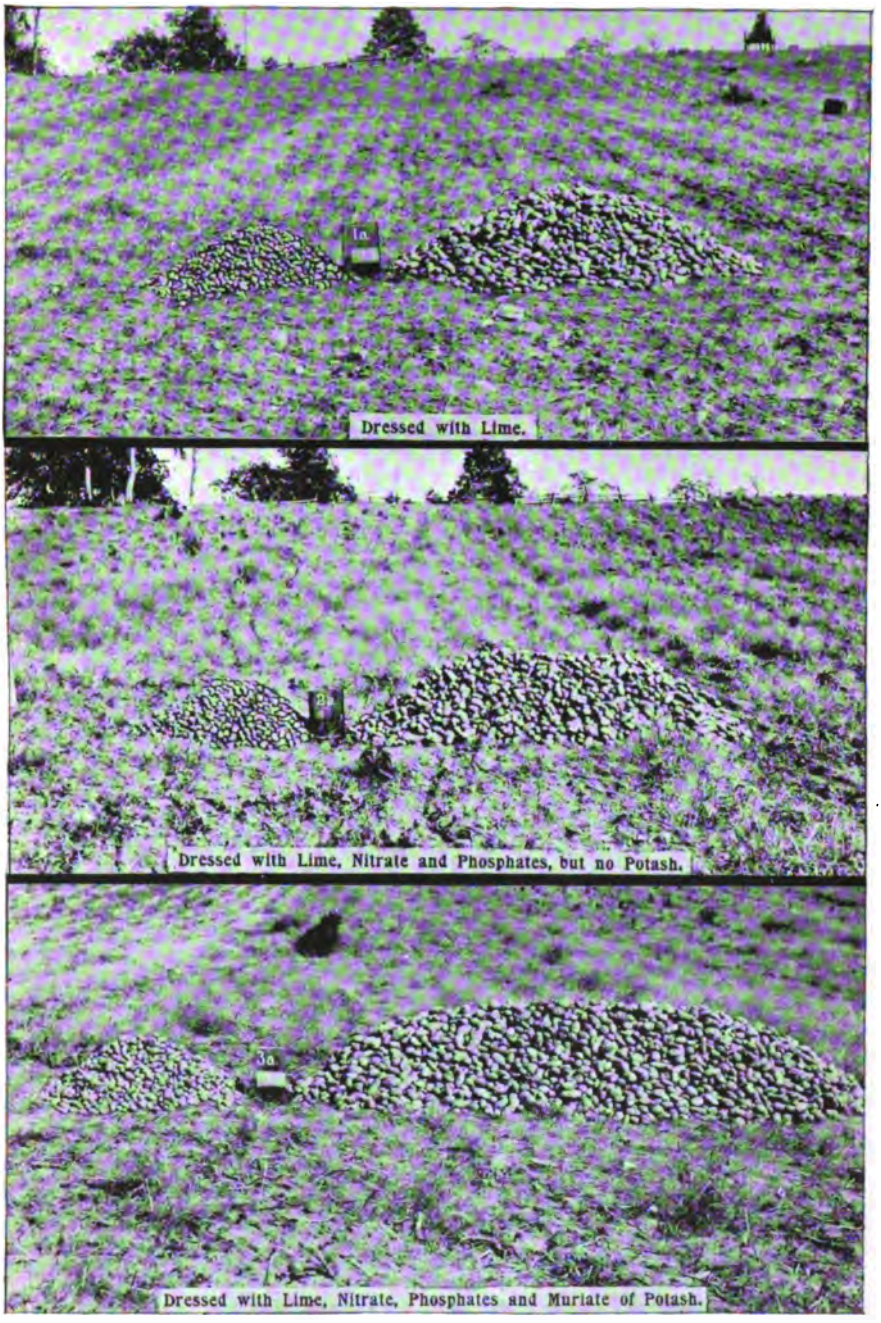
Dressed with Lime.
Dressed with Lime, Nitrate and Phosphates, but no Potash.
Dressed with Lime, Nitrate, Phosphates and Muriate of Potash.

FIELD EXPERIMENT WITH POTATOES. Conducted by T. J. Stroud.

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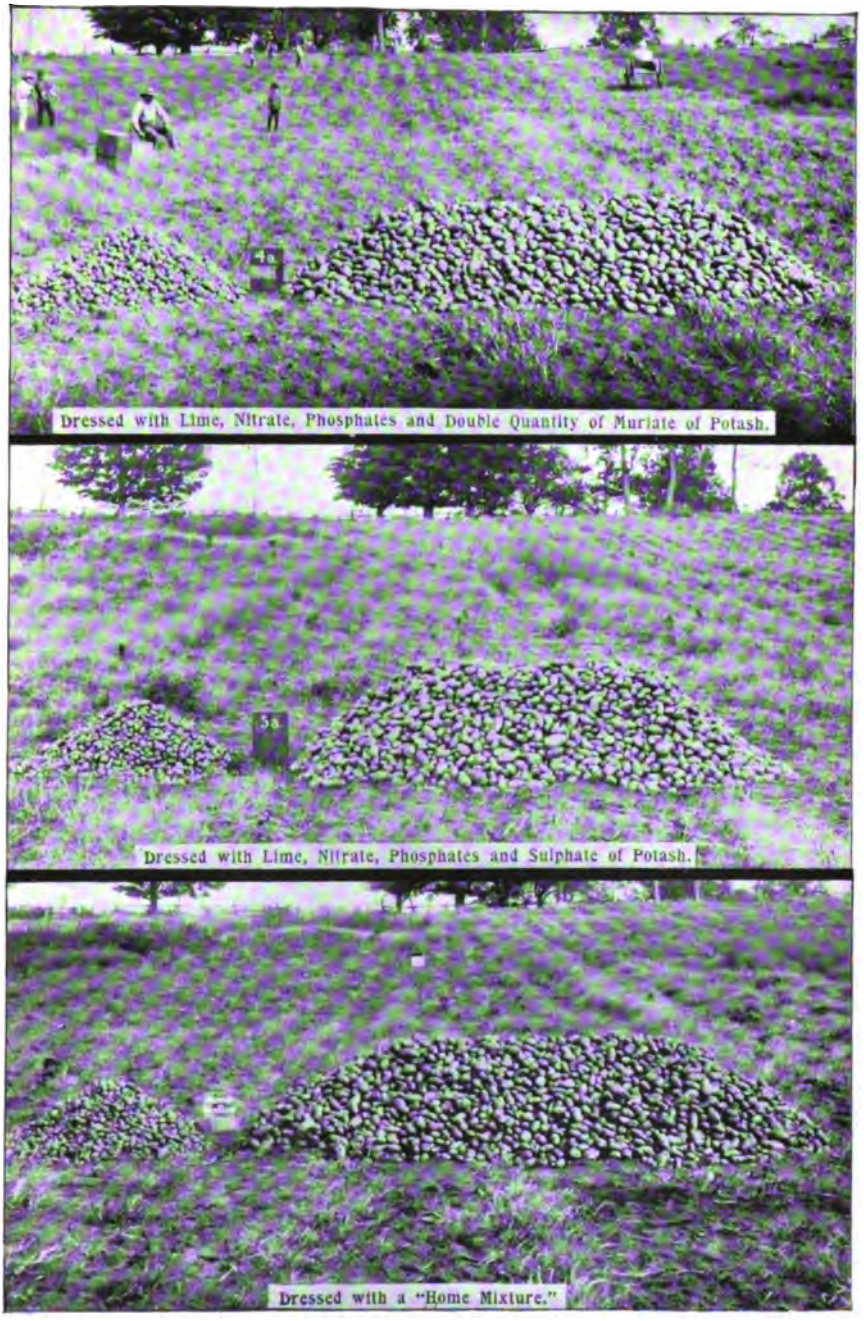
4a
Dressed with Lime, Nitrate, Phosphates and Double Quantity of Muriate of Potash.
3a
Dressed with Lime, Nitrate, Phosphates and Sulphate of Potash.
Dressed with a "Home Mixture."

FIELD EXPERIMENT WITH POTATOES. Conducted by T. J. Stroud.

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If the yield of the plot which received no fertilizer is called 100, the yields from the other plots will rank as follows:

No. of Plot.	Dressed with	Relative yield.
1.	Nothing,	100
1a.	Lime,	137
2.	Nitrate and acid phosphate,	192
2a.	Same as 2, with lime,	169
3.	Nitrate, acid phosphate and muriate of potash,	285
3a.	Same as 3, with lime,	306
4.	Nitrate, acid phosphate and double quantity of muriate,	325
4a.	Same as 4, with lime,	319
5.	Nitrate, acid phosphate and sulphate of potash,	268
5a.	Same as 5, with lime,	254
6.	Florida soft phosphate,	139
6b.	Nitrate and Florida phosphate,	183
7.	Muriate and Florida phosphate,	231
7b.	Nitrate, Florida phosphate and muriate of potash,	251
8.	Home mixture,	321
9.	Nitrate and wood ashes,	255

The results of this experiment may be summarized as follows:

1. The yields on plot 4, nitrate, acid phosphate and double quantity of muriate, on 4a, the same fertilizer as on 4 with lime added, and on plot 8, home-mixture, are essentially alike, three times as large as from plot 1, which had no fertilizer, and amounted to over 230 bushels of potatoes per acre.

2. The addition of lime to the fertilizers had but little effect, and in three out of four cases depressed the yield.

3. Muriate of potash gave a larger yield of potatoes per acre than an equivalent quantity of sulphate, by 25 bushels.

4. Florida phosphate alone, plot 6, increased the yield about as much as an application of lime; with nitrate, plot 6b, it still further increased the yield. With potash, plot 7, the yield was greater than with nitrate alone, but the combination of nitrate, Florida phosphate and muriate, plot 7b, yielded more than any two of the three, but 25 bushels per acre less than an equivalent quantity of dissolved bone black with nitrate and muriate, plot 3.

5. The potatoes from the four plots that received muriate contained in their fresh substance 16.22, 16.48, 16.16, 15.44 per cent. of starch respectively, the average being 16.07. The potatoes from the two plots which received sulphate of potash contained 16.69 and 16.16 respectively, the average of which is 16.42.

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The potatoes on the plot which received most muriate had a smaller per cent. of starch than any others, with two exceptions (5a and 6b), and the potatoes on the plot with sulphate of potash had the highest per cent. of starch of any except those from plot 2. It is to be noticed, however, that the per cent. of starch in potatoes on plot 5a, which was dressed with high grade sulphate and lime, was as low as any in the experiment, excepting plot 6b.

6. The lower per cent. of starch in the potatoes raised with muriate is due to their higher per cent. of water. The per cent. of starch *in the dry substance* of the potatoes is highest where muriate was used, plot 3. The average per cent. of starch in the dry substance of the potatoes from the four plots on which muriate of potash was used is 76.32; the average on the two sulphate of potash plots is 75.60.

The soil of the experiment field was strikingly deficient in available potash, nitrogen and phosphoric acid. Thus nitrate and dissolved bone black increased the yield of the soil by 92 bushels per acre, and muriate added to the chemicals named made a further increase of 93 bushels.

In this experiment, muriate of potash gave a larger yield than the equivalent amount of sulphate of potash, by 25 bushels per acre.

The starch-content of the fresh potatoes was as high with sulphate of potash as where no fertilizer was used.

The starch-content in the fresh potatoes raised with muriate was about .5 per cent. less than in those raised with equivalent sulphate.

Doubling the quantity of muriate increased the yield and still further depressed the per cent. of starch.

The lower content of starch in potatoes raised with muriate was wholly due to the larger amount of water in them. The dry matter of potatoes raised with muriate contained more starch than those raised with sulphate of potash.

The results here reported naturally differ with the character of the land, quantity of nitrogen applied, weather conditions, etc.

In general the potatoes where muriate was applied contained less starch, by half a per cent. or less, than those raised with sulphate of potash. The yield of potatoes is most likely to be larger with muriate than with sulphate of potash.

The actual potash in sulphate of potash costs about 12 per cent. more than in muriate, so that if 80 pounds of actual potash were applied per acre, the added cost of using sulphate would be about 75 cents.

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It is not always and every where advisable to use sulphate rather than muriate of potash on potato land.

When yield alone is sought and there is no possibility of getting an extra price on account of quality, the muriate may be used, partly because, pound for pound of actual potash, it is cheaper than the sulphate, but mainly because it is likely to produce a larger yield.

When used, its unfavorable effect on the quality of the tubers may probably be lessened by putting it on the land early, even the fall before.

When potatoes are to be raised for seed, or when an increased price may be secured because of extra quality of tubers, the sulphate should be used.

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EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS.

FINAL REPORT ON THE FERMENTED CROPS OF 1894.

By E. H. Jenkins.

The object of these experiments is to study the effects of certain fertilizers commonly used by our Connecticut growers on the quality of wrapper-leaf tobacco. Each plot under experiment receives the same fertilizers for a term of years in order to test these fertilizers under the varying climatic conditions which a succession of years affords, and final judgment on the quality of the crops is made after they have been fermented in the case and are ready for manufacture.

The work was begun in 1892 and has been carried on each year since then by this Station, in connection with the Connecticut Tobacco Experiment Company.

A full description of this experiment will be found in former reports of this Station, viz.: 1892, pp. 1–24; 1893, pp. 112–144; 1894, pp. 254–284.

An account of the growing, harvesting and curing of the crop of 1894 is printed on pages 270 to 279 of the 17th Annual Report of this Station for 1894.

Samples of the long and short wrappers from each plot, with top leaves and seconds sufficient to fill the case, were cased down at the warehouse of Mr. L. B. Haas in Hartford, on Dec. 13th, 1894. The case lay undisturbed till Dec. 10th, 1895, when it was opened and the samples examined.

Shrinkage during Fermentation.

The tobacco weighed 343 pounds when it was cased. After fermentation it weighed 307 pounds, having lost during twelve months 36 pounds, or 11.1 per cent. The crops of 1892 and 1893 lost about 14 per cent. during fermentation. The crop of 1892 was "well sweated," that of 1893 "unsweated," and that of 1894, which lost nearly 3 per cent. less than the others, "well sweated." It is the *nature* of the change during fermentation—about which almost nothing is known at present—and not the total loss in the case, which determines the effect of the process on the quality of the leaf.

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Judgment of the Expert.

Each lot of tobacco was marked with a number, different from the one used in the previous year, and which gave no indication of the plot from which the tobacco came.

The lots were examined and graded by Mr. Benjamin L. Haas of Hartford, who has graded the two previous crops. Mr. Haas devoted two days to the work, and there has thus been secured a perfectly unbiased and intelligent judgment by an expert fully acquainted with the present requirements of the trade.

A strict judgment has been given, noting all defects in the leaf.

The crops on the experiment field were in general of quite as good quality as those grown elsewhere in the neighborhood.

Following is the grading given by Mr. Haas, in detail:

Lot A.

Fertilizers: 1360 lbs. cottonseed meal and 1560 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 150 lbs. phosphoric acid and 339 lbs. potash. Cost, $53.12 per acre.

Yield:	740 lbs.	long wrappers per acre.
	230 "	short " " "
Total	970 "	

Quality:—*Burn*, free, does not coal, holds fire fairly well. *Ash*, clear white. *Vein*, small, some white vein. *Texture*, well sweated, open grain, thin and good finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, very profitable. *Soundness*, sound. *Stem*, small. *Relative Rank*, 5th.

Lot B.

Fertilizers: 1826 lbs. linseed meal, 1572 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 143 lbs. phosphoric acid and 339 lbs. potash. Cost, $60.02 per acre.

Yield:	690 lbs.	long wrappers per acre.
	205 "	short " " "
Total	895 "	

Quality:—*Burn*, does not coal, holds fire very well. *Ash*, clear gray. *Vein*, small, curly. *Texture*, well sweated, good grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, clear, bright, medium. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 6th.

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LOT C.

Fertilizers: 2260 lbs. cottonseed meal, 1480 lbs. cotton hull ashes per acre, containing 175 lbs. nitrogen, 170 lbs. phosphoric acid and 339 lbs. potash. Cost, $63.24 per acre.

Yield: 880 lbs. long wrappers per acre.
260 " short " " "
Total 1140 "

Quality:—*Burn*, does not coal, holds fire very well. *Ash*, clear white, hard. *Vein*, good. *Texture*, well sweated, good grain, good finish. *Size*, little above medium. *Ripeness*, ripe. *Colors*, dark, mottled. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, small. *Relative rank*, 11th.

LOT D.

Fertilizers: 2720 lbs. cottonseed meal, 1440 lbs. cotton hull ashes per acre, containing 210 lbs. nitrogen, 180 lbs. phosphoric acid and 340 lbs. potash. Cost, $68.44 per acre.

Yield: 1050 lbs. long wrappers per acre.
280 " short " " "
Total 1330 "

Quality:—*Burn*, does not coal, fairly free. *Ash*, clear white. *Vein*, curly, with some white vein. *Texture*, well sweated, open grain, lacks finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, medium. *Yield*, unprofitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 16th.

LOT E.

Fertilizers: 1900 lbs. castor pomace and 1640 lbs. cotton hull ashes per acre, containing 105 lbs. nitrogen, 148 lbs. phosphoric acid and 347 lbs. potash. Cost, $59.70 per acre.

Yield: 710 lbs. long wrappers per acre.
240 " short " " "
Total 950 "

Quality:—*Burn*, coals slightly, holds fire fairly well. *Ash*, mixed gray. *Vein*, curly and white. *Texture*, medium, well sweated, close grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium to dark, mottled. *Yield*, unprofitable. *Soundness*, sound. *Stem*, medium to small. *Relative rank*, 28th.

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LOT F.

Fertilizers: 1820 lbs. linseed meal, 640 lbs. cotton hull ashes and 260 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 153 lbs. phosphoric acid and 152 lbs. potash. Cost, $42.48 per acre.

Yield:	820	lbs.	long	wrappers	per acre.
	260	"	short	"	" "
Total	1080	"			

Quality:—*Burn*, coals slightly, holds fire fairly. *Ash*, clear white, does not flake. *Vein*, good. *Texture*, well sweated, inclined to be close grain, good finish. *Size*, little above medium. *Ripeness*, ripe. *Colors*, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 4th.

LOT G.

Fertilizers: 3160 lbs. castor pomace and 1540 lbs. cotton hull ashes per acre, containing 175 lbs. nitrogen, 162 lbs. phosphoric acid and 338 lbs. potash. Cost, $72.52 per acre.

Yield:	860	lbs.	long	wrappers	per acre.
	280	"	short	"	" "
Total	1140	"			

Quality:—*Burn*, coals slightly, fairly free. *Ash*, clear gray. *Vein*, medium, white vein. *Texture*, thin, well sweated, good grain, fair finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, clear, dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 15th.

LOT H.

Fertilizers: 3780 lbs. castor pomace and 1540 lbs. cotton hull ashes per acre, containing 210 lbs. nitrogen, 171 lbs. phosphoric acid and 340 lbs. potash. Cost, $79.56 per acre.

Yield:	1050	lbs.	long	wrappers	per acre.
	280	"	short	"	" "
Total	1330	"			

Quality:—*Burn*, does not coal, holds fire very well. *Ash*, clear white, hard. *Vein*, good. *Texture*, well sweated, good grain, lacks finish. *Size*, little above medium. *Ripeness*, ripe. *Colors*, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 14th.

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LOT I.

Fertilizers: 1900 lbs. castor pomace, 1640 lbs. cotton hull ashes, 640 lbs. nitrate of soda (the latter in two applications after planting) per acre, containing 208 lbs. nitrogen, 148 lbs. phosphoric acid and 347 lbs. of potash. Cost, $75.70 per acre.

Yield:	920 lbs.	long wrappers per acre.
	250 "	short " " "
Total	1170 "	

Quality:—*Burn*, does not coal, fairly free. *Ash*, clear gray. *Vein*, inclined to be curly and some white. *Texture*, well sweated, grain rather open, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, dark and somewhat mottled. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, rather small. *Relative rank*, 20th.

LOT J.

Fertilizers: 1900 lbs. castor pomace, 1640 lbs. cotton hull ashes, and 640 lbs. nitrate of soda (the latter applied after planting) per acre, containing 208 lbs. nitrogen, 148 lbs. phosphoric acid and 347 lbs. potash. Cost, $75.70 per acre.

Yield:	980 lbs.	long wrappers per acre.
	260 "	short " " "
Total	1240 "	

Quality:—*Burn*, does not coal, fairly free. *Ash*, clear gray. *Vein*, some white, medium. *Texture*, well sweated, rather close grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium to dark, somewhat mottled. *Yield*, fairly desirable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 19th.

LOT K.

Fertilizers: 1360 lbs. cottonseed meal, 1160 lbs. double sulphate of potash and magnesia, and 380 lbs. Cooper's bone per acre, containing 105 lbs. of nitrogen, 149 lbs. phosphoric acid and 341 lbs. of potash. Cost, $40.55 per acre.

Yield:	930 lbs.	long wrappers per acre.
	225 "	short " " "
Total	1155 "	

Quality:—*Burn*, coal slightly, holds fire fairly. *Ash*, clear gray. *Vein*, inclined to be white. *Texture*, well sweated, good grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium, mottled. *Yield*, not profitable. *Soundness*, fairly sound. *Stem*, rather small. *Relative rank*, 17th.

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LOT L.

Fertilizers: 1360 lbs. cottonseed meal, 1160 lbs. double sulphate of potash and magnesia, 380 lbs. Cooper's bone, and 300 lbs. lime per acre, containing 105 lbs. of nitrogen, 149 lbs. phosphoric acid and 341 lbs. of potash. Cost, $43.55 per acre.

Yield: 760 lbs. long wrappers per acre.
270 " short " " "
Total 1030 "

Quality:—*Burn*, does not coal, does not hold fire well. *Ash*, clear white. *Vein*, small, with some white. *Texture*, thin, well sweated, open grain, good finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 7th.

LOT M.

Fertilizers: 1360 lbs. cottonseed meal, 660 lbs. high grade sulphate of potash and 380 lbs. Cooper's bone per acre, containing 105 lbs. of nitrogen, 149 lbs. phosphoric acid and 338 lbs. of potash. Cost, $41.30 per acre.

Yield: 680 lbs. long wrappers per acre.
210 " short " " "
Total 890 "

Quality:—*Burn*, coals slightly, holds fire fairly well. *Ash*, mixed gray. *Vein*, small, some white. *Texture*, well sweated, close grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium to light but mottled. *Yield*, unprofitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 26th.

LOT N.

Fertilizers: 1360 lbs. cottonseed meal, 660 high grade sulphate of potash, 380 lbs. Cooper's bone and 300 lbs. lime per acre, containing 105 lbs. nitrogen, 149 lbs. phosphoric acid and 338 lbs. potash. Cost, $44.30 per acre.

Yield: 720 lbs. long wrappers per acre.
220 " short " " "
Total 940 "

Quality:—*Burn*, coals very slightly, holds fire fairly. *Ash*, mixed gray. *Vein*, inclined to be white. *Texture*, well sweated, fair grain but inclined to be close, lacks finish. *Size*, good. *Ripeness*, ripe. *Colors*, medium, mottled. *Yield*, unprofitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 25th.

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LOT O.

Fertilizers: 1360 lbs. cottonseed meal, 580 lbs. carbonate of potash and 380 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 149 lbs. phosphoric acid and 339 lbs. potash. Cost, $72.45 per acre.

Yield:	780	lbs.	long wrappers	per acre.
	240	"	short "	" "
Total	1020	"		

Quality:—*Burn*, coals, holds fire fairly. *Ash*, mixed gray. *Vein*, small amount of white vein, otherwise good. *Texture*, well sweated, fairly open grain, good finish. *Size*, very desirable. *Colors*, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, small. *Relative rank*, 13th.

LOT P.

Fertilizers: 1360 lbs. cottonseed meal, 1740 lbs. double carbonate of potash and magnesia, and 380 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 149 lbs. phosphoric acid and 340 lbs. potash. Cost, $57.08 per acre.

Yield:	660	lbs.	long wrappers	per acre.
	220	"	short "	" "
Total	880	"		

Quality:—*Burn*, does not coal, holds fire very well. *Ash*, hard and white. *Vein*, good. *Texture*, well sweated, very thin, open grain, good finish. *Size*, very desirable. *Ripeness*, ripe. *Colors*, fairly clear, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, small. *Relative rank*, 2d.

LOT Q.

Fertilizers: 2000 lbs. Baker's A. A. Superphosphate, 4000 lbs. Baker's tobacco manure per acre, containing 241 lbs. nitrogen, 489 lbs. phosphoric acid and 495 lbs. potash.

Yield:	920	lbs.	long wrappers	per acre.
	190	"	short "	" "
Total	1110	"		

Quality:—*Burn*, coals slightly, does not hold fire. *Ash*, muddy gray. *Vein*, prominent, curly. *Texture*, well sweated, thin, papery, close grain. *Size*, medium to large. *Ripeness*, ripe. *Colors*, medium mottled. *Yield*, unprofitable. *Soundness*, sound. *Stem*, inclined to be large. *Relative rank*, 29th.

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LOT R.

Fertilizers: 2000 lbs. Stockbridge Tobacco Manure and 500 lbs. of the same, used as a starter, per acre, containing 149 lbs. nitrogen, 281 lbs. phosphoric acid and 283 lbs. potash.

Yield:	730	lbs.	long	wrappers	per acre.
	230	"	short	"	" "
Total	960	"			

Quality:—*Burn*, coals slightly, does not hold fire. *Ash*, mixed gray. *Vein*, small, but some white. *Texture*, well sweated, open grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, dark, mottled. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, small. *Relative rank*, 23d.

LOT S.

Fertilizers: 3000 lbs. Stockbridge Tobacco Manure, 500 lbs. of the same, used as a starter per acre, containing 209 lbs. nitrogen, 393 lbs. phosphoric acid and 396 lbs. potash.

Yield:	910	lbs.	long	wrappers	per acre.
	250	"	short	"	"
Total	1160	"			

Quality:—*Burn*, coals slightly, holds fire fairly well. *Ash*, mixed gray. *Vein*, inclined to be white. *Texture*, well sweated, fair grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, medium, mottled. *Yield*, not profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 22d.

LOT T.

Fertilizers: 880 lbs. dry ground fish, 440 lbs. nitrate of soda, and 300 lbs. lime per acre, containing 142 lbs. nitrogen, and 60 lbs. phosphoric acid. Cost, $31.60 per ton.

Yield:	740	lbs.	long	wrappers	per acre.
	160	"	short	"	"
Total	900	"			

Quality :—*Burn*, coals slightly, does not hold fire. *Ash*, white. *Vein*, white and curly. *Texture*, well sweated, open grain, without finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, dark and mottled. *Yield*, very unprofitable. *Soundness*, sound. *Stem*, small. *Relative rank*, 27th.

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LOT U.

Fertilizers: 2200 lbs. Mapes' Tobacco Manure, wrapper brand, and 600 lbs. Mapes' Starter per acre, containing 158 lbs. of nitrogen, 211 lbs. phosphoric acid, and 278 lbs. potash.

Yield:	1110	lbs.	long wrappers	per acre.
	180	"	short "	"
Total	1290	"		

Quality :—*Burn*, coals slightly, holds fire fairly. *Ash*, medium, clear gray. *Vein*, prominent, curly, inclined to be white. *Texture*, well sweated, good grain. *Size*, too large. *Ripeness*, ripe. *Colors*, medium. *Yield*, unprofitable. *Soundness*, sound. *Stem*, large. *Relative rank*, 18th.

LOT V.

Fertilizers: 2400 lbs. Mapes' Tobacco Manure, wrapper brand, and 400 lbs. Mapes' Starter per acre, containing 163 lbs. nitrogen, 196 lbs. phosphoric acid, and 294 lbs. potash.

Yield:	870	lbs.	long wrappers	per acre.
	225	"	short "	"
Total	1095	"		

Quality :—*Burn*, coals slightly, does not hold fire. *Ash*, mixed gray. *Vein*, small, no white vein. *Texture*, thin, well sweated, open grain, no finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, medium to dark, dry. *Yield*, unprofitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 24th.

LOT W.

Fertilizers: 2400 lbs. Mapes' Tobacco Manure per acre, containing 151 lbs. of nitrogen, 143 lbs. phosphoric acid, and 280 lbs. potash.

Yield:	990	lbs.	long wrappers	per acre.
	270	"	short "	"
Total	1260	"		

Quality :—*Burn*, inclined to coal, does not hold fire very well. *Ash*, mixed gray, does not flake. *Vein*, small, inclined to be white. *Texture*, well sweated, thin, good grain, good style. *Size*, little above medium. *Ripeness*, ripe. *Colors*, medium to light. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 8th.

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LOT X.

Fertilizers: 2000 lbs. Sanderson's Tobacco Formula per acre, containing 103 lbs. nitrogen, 281 lbs. phosphoric acid, and 105 lbs. potash.

Yield: 680 lbs. long wrappers per acre.
240 " short " "
Total 920 "

Quality:—*Burn*, coals slightly, does not hold fire. *Ash*, mixed gray. *Vein*, small. *Texture*, well sweated, open grain, good finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, fair. *Soundness*, sound. *Stem*, small. *Relative rank*, 9th.

LOT Y.

Fertilizers: 1360 lbs. cotton seed meal, 8540 lbs. wood ashes, and 80 lbs. Cooper's bone per acre, containing 105 lbs. nitrogen, 147 lbs. phosphoric acid, 340 lbs. potash. Cost, $70.34 per acre.

Yield: 840 lbs. long wrappers per acre.
200 " short " "
Total 1040 "

Quality:—*Burn*, coals slightly, holds fire fairly well. *Ash*, clear gray. *Vein*, some white. *Texture*, well sweated, open grain, good finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, clear, medium to dark. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 12th.

LOT Z.

Fertilizers: 1300 lbs. dry ground fish, 1260 lbs. double sulphate of potash and magnesia, and 200 lbs. Cooper's bone per acre, containing 104 lbs. nitrogon, 146 lbs. phosphoric acid, and 342 lbs. potash. Cost, $47.60 per acre.

Yield: 670 lbs. long wrappers per acre.
250 " short " "
Total 920 "

Quality:—*Burn*, does not coal, holds fire fairly well. *Ash*, clear gray. *Vein*, small, some white. *Texture*, too hard sweated, thin, open grain, good finish. *Size*, very desirable. *Ripeness*, ripe. *Colors*, dark and mottled. *Yield*, very profitable. *Soundness*, sound. *Stem*, very small. *Relative rank*, 3d.

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LOT AA.

Fertilizers: 10 to 12 cords stable manure, on half the plot 500 lbs. Swift-Sure Superphosphate per acre, containing (estimated) 125 lbs. nitrogen, 143 lbs. phosphoric acid, and 171 lbs. potash.

Yield:	380	lbs.	long wrappers per acre.
	180	"	short " "
Total	560	"	

Quality:—*Burn*, coals slightly, holds fire well. *Ash*, mixed gray. *Vein*, small, very little white vein. *Texture*, well sweated, thin, open grain, good finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, light to medium. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 1st.

LOT BB.

Fertilizers: 6000 lbs. tobacco stems, 2640 lbs. castor pomace, on half the plot 500 lbs. Swift-sure Superphosphate per acre, containing (estimated) 253 lbs. nitrogen, 146 lbs. phosphoric acid and 539 lbs. potash. Cost, $83.18.

Yield:	600	lbs.	long wrappers per acre.
	180	"	short " "
Total	780	"	

Quality:—*Burn*, coals very slightly, holds fire fairly well, free burn. *Ash*, clear gray. *Vein*, small, some white. *Texture*, well sweated, rather thin, open grain, lacks finish. *Size*, desirable. *Ripeness*, ripe. *Colors*, dark. *Yield*, fairly profitable. *Soundness*, sound. *Stem*, medium to small. *Relative rank*, 21st.

LOT CC.

Fertilizers: 3000 lbs. Pinney's Formula per acre, containing 131 lbs. nitrogen, 196 lbs. phosphoric acid and 305 lbs. potash.

Yield:	620	lbs.	long wrappers per acre.
	230	"	short " "
Total	850	"	

Quality:—*Burn*, coals, holds fire fairly well. *Ash*, mixed gray. *Vein*, small, not white. *Texture*, well sweated, open grain, good finish. *Size*, medium to large. *Ripeness*, ripe. *Colors*, clear, medium to dark. *Yield*, very profitable. *Soundness*, sound. *Stem*, medium. *Relative rank*, 10th.

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The lots in order of their value as wrappers, taking all points into consideration, are graded as follows:

AA (best),	P,	Z,	F,	A,	B,	L,	W,	X,	CC,	C,
1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.
Y,	O,	H,	G,	D,	K,	U,	J,	I,	BB,	
12th.	13th.	14th.	15th.	16th.	17th.	18th.	19th.	20th.	21st.	
S,	R,	V,	N,	M,	T,	E,	Q,			
22d.	23d.	24th.	25th,	26th.	27th.	28th.	29th.			

General Remarks.—The short wrappers from all the plots contain a larger per cent. of fine wrappers than the short wrappers of the experiment crops of 1892 or 1893 contained.

The first ten in the above list differ *very* little in quality. The tobaccos all show a great improvement over the 1893 crops, and the first fifteen in the above list are all very desirable tobaccos.

The presence of white vein has impaired the salability of the crops somewhat, but this is considered a defect of curing rather than of growing.

Discussion of the Results.

The crop of 1894 was a dry-weather crop. During the tobacco-growing season of 1892 nearly 16 inches of rain fell, and the quality of the crop was exceptionally good. In 1893 only 6.2 inches of rain fell while the crop was standing, and the crop was exceptionally poor: its one good feature being the "burn," which was even better than that of 1892 crop.

In 1894 the rain-fall, while the tobacco was in the field, amounted to 7.16 inches, an inch more than in 1893. On fifteen days out of the 83 days the conditions were reported as "too dry" by the superintendent of the field work.

The total rain-fall, however, gives a very inadequate idea of the supply of water to the crop. A succession of showers at tolerably uniform intervals is most favorable to the crop. Two or three heavy down-pours of rain with long periods of dryness between, even if more rain falls than in the former case, are much less favorable.

In 1894 there was a time in June when no rain fell for 16 days, and no rain fell for the last 10 days of June, but for the rest of the season some rain fell in every week.

The crop received no great amount of rain, but the rain-fall was well distributed and the quality of the crop was very fair.

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Comparative Fire-Holding Capacity.

In the following table is given the relative fire-holding capacity of the long and short wrappers from each plot determined by Messrs. Winton and Ogden, by the method described in the Report of this Station for 1893, p. 124.

The lot which held fire the shortest time is marked 100, and the other lots are so marked as to express numerically their capacity for holding fire: for example, lot T held fire for a shorter time than any other (100), lot A held fire more than four times as long (436).

Comparative Fire-Holding Capacity. Fermented Crop of 1894.

	Long Wrappers.	Short Wrappers.	Calculated from mean of both.	Average number of seconds during which leaf holds fire. Unfermented.	Fermented.
A	485	409	436	11.9	45.8
B	331	315	318	11.0	33.4
C	292	241	260	12.0	27.3
D	251	197	218	11.8	22.9
E	257	209	227	9.1	23.9
F	150	100	120	7.8	12.6
G	255	340	298	9.7	31.2
H	400	190	277	11.9	29.0
I	223	198	206	10.6	21.6
J	194	215	204	14 0	21.5
K	228	237	230	7.6	24.1
L	162	178	168	6.8	17.6
M	172	127	145	7.9	15.2
N	162	217	190	9.6	19.9
O	182	248	216	11.5	22.7
P	430	337	374	13.7	39.3
Q	107	111	107	5.5	11.3
R	153	192	172	10.2	18.1
S	190	243	216	8.1	22.7
T	100	103	100	6.9	10.5
U	137	204	172	7.8	18.0
V	160	180	170	8.0	17.6
W	181	230	205	8.9	21.6
X	101	103	101	6.4	10.6
Y	305	309	303	15.2	31.8
Z	253	250	248	10.6	26.0
AA	216	326	273	7.8	28.7
BB	170	239	205	9.8	21.5
CC	298	192	236	9.9	24.8

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The fire-holding capacity of the leaf was in every case increased by the fermentation, though not by any means equally in all cases.

The *average* fire-holding capacity of the three year's crops already fermented are:

	Before Fermentation.	After Fermentation.
Crop of 1892.....	9.6	24.4
Crop of 1893.....	9.0	18.0
Crop of 1894.....	9.7	23.2

There is substantial agreement in most cases between the judgment as to fire-holding capacity by the expert and the results of laboratory tests.

Thus the seven lots L, Q, R, T, V, W, X, which did not hold fire well in the expert's judgment, were all far below the average fire-holding capacity as determined in the laboratory. The five lots judged to hold fire "very well," B, C, H, P, AA, had a relatively high fire-holding capacity as determined by the chemist.

Exceptional are lots F, M, N, U, BB, which "hold fire fairly" in the opinion of the expert, but as determined by laboratory tests are quite below the average, and A and Y, which are judged to "hold fire fairly," yet have a very high fire-holding capacity as determined in the laboratory.

Tendency to coal is not always associated with small fire-holding capacity. Lots O and CC, which "coaled" most, had a fire-holding capacity above the average.

The relative average fire-holding capacity of all the lots which did not coal was 265, while that of the lots which coaled slightly was 190.

Number of Fermented Leaves to the Pound.

On page 281, Report of 1894, are given the number of leaves per pound of each lot of *pole-cured* tobacco of this crop.

The number of leaves per pound of this same crop after fermentation in the case, appear in the following table.

From 25 to 35 leaves were weighed on a balance sensitive to $\frac{1}{50}$ of an ounce, and from these weights the results in the table are computed.

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NUMBER OF FERMENTED LEAVES TO THE POUND. CROP OF 1894.

	Long Wrappers.	Short Wrappers.		Long Wrappers.	Short Wrappers.
A	68	101	P	76	111
B	66	93	Q	72	94
C	67	97	R	68	109
D	73	93	S	61	96
E	80	101	T	77	96
F	72	89	U	63	95
G	70	97	V	72	89
H	74	89	W	76	95
I	65	111	X	71	97
J	73	105	Y	72	93
K	70	95	Z	70	108
L	66	88	AA	64	92
M	78	112	BB	70	85
N	72	101	CC	64	90
O	79	106			

The average of these figures is as follows:

NUMBER OF LEAVES TO THE POUND.

	Pole-cured.	Fermented.
Short wrappers	88	97
Long wrappers	64	71

EFFECTS OF DIFFERENT FORMS OF NITROGEN.

Cotton Seed Meal and Castor Pomace.

Cotton Seed Meal and Castor Pomace were each applied to three plots in quantities supplying 105, 175 and 210 lbs. per acre of nitrogen respectively, with 150 lbs. of phosphoric acid and 340 lbs. of potash in form of cotton hull ashes.

In 1894 the yield of wrappers was practically the same from the Cotton Seed plots as from the Castor Pomace plots.

In both cases the yield regularly increased with the increase in nitrogen.

The number of wrapper leaves per pound was practically the same where cotton seed was used as where castor pomace was used.

In both cases the number of leaves per pound was slightly greater with the smaller amount of nitrogen than with the larger.

The per cent. of wrappers in the crops was nearly the same with both fertilizers and increased in each case with the increase of nitrogen in the fertilizers.

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The quality of the leaf raised on Cotton Seed Meal was somewhat better than that raised with Castor Pomace.

Thus lots A, C, D (Cotton Seed Meal) were graded 5th, 11th and 16th. Lots E, G, H (Castor Pomace) were graded 28th, 15th, 14th. Excepting lot E, there is, however, little difference in quality between the two.

Linseed Meal.

Plot B, which received 105 pounds of nitrogen per acre in this form, yielded 65 pounds less per acre of wrappers than the corresponding plots A and E, dressed with Cotton Seed and Pomace; the per cent. of wrappers in the crop was about the same, the weight per leaf was somewhat greater, and the quality was of the best, ranking 6th.

Plot F, with the same amount of linseed meal and phosphoric acid, but half the quantity of potash that was put on B, yielded 115 pounds more of wrappers per acre than A or E, but in other ways the crop differed little from that on F, and was graded 4th.

Practically the same results were obtained with the previous crop.

Fish.

Plot Z was dressed with 1300 pounds of dry ground fish, which supplied 105 pounds of nitrogen and 1260 pounds of double sulphate of potash and magnesia. It is not strictly comparable with plots A (Cotton Seed Meal), E (Castor Pomace), and B (Linseed Meal), in that the form of potash was different,—though the quantity of actual potash supplied was the same.

The yield of wrappers was somewhat less than from plots A and E, and somewhat more than from B. The quality of leaf was, however, nearly as good as any, ranking 3d.

Nitrate of Soda, at First and Second Cultivation.

(Plots I and J compared with H.)

The point of this experiment is to ascertain the effect on the crop of supplying one-third of the nitrogen of a heavy application (210 pounds), as a top dressing in the form of nitrate of soda in one application at the time of the first cultivation (plot I), or in two applications at the time of the first and second cultivation (plot J). The effect in both cases was decidedly injurious to the

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quality of the wrappers, though plot J yielded 180 pounds more of wrappers than H. In 1893 J yielded 165 pounds more wrappers than H, and the quality of the wrappers was even better. Plot I, which received all the nitrate in one application, produced less tobacco and of inferior quality.

In 1894 the effect in each case was somewhat injurious. J produced 70 pounds more wrapper leaf than I, but 90 pounds less than H. The wrapper leaves on I and J were somewhat lighter in weight than on H, but the quality was not quite as good.

Stable Manure.

Plot AA was dressed with 10 to 12 cords of stable manure and some Swift Sure Superphosphate as a starter.

The yield of wrappers was very small, 560 pounds per acre, scarcely more than half the average yield of all the plots taken together.

The per cent. of wrappers in the crop was also the smallest of any. But the *quality* of the leaf was the very best of all and was ranked first. The calculated quantity of nitrogen on this plot was 125 pounds per acre. It is quite likely that this was not all readily available, and that the small crop may be explained by a deficiency of nitrogen.

Tobacco Stems.

Plot BB, dressed with three tons of tobacco stems per acre and 2640 pounds of Castor Pomace, with 500 pounds of Swift Sure Superphosphate, yielded 780 pounds of wrapper leaf, which was of less than average quality.

Effect of Different Forms of Potash.

Plots A, K, L, M, N, O, P, Y, were dressed with like quantities of nitrogen (in form of Cotton Seed Meal), phosphoric acid and potash; but the potash was supplied in different forms.

The plot which received double sulphate of potash and magnesia yielded the most wrappers per acre, 1155 pounds.

The yield from the double sulphate of potash and magnesia with lime, carbonate of potash, and wood ashes were about alike, 1020 to 1040 pounds. Cotton hull ashes and high grade sulphate with lime yielded 970 to 980 pounds, while the high grade sulphate without lime, and the double carbonate of potash and magnesia yielded least (880 to 890 pounds of wrappers per acre).

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The expert graded the lots raised with cotton hull ashes, double sulphate of potash and magnesia *with lime*, double carbonate of potash and magnesia and wood ashes, 5th, 7th, 2d and 12th, respectively, among the very best in the whole experiment.

The lots raised with carbonate of potash, and double sulphate of potash and magnesia *without lime*, ranked next, 13th and 17th, while those raised with high grade sulphate, with and without lime, were among the poorest, 25th and 26th.

Notice is also called to the facts that lot Z raised with fish and double sulphate of potash and magnesia ranked 3d, and that lot F, which received only half the quantity of potash applied to plot B, ranked 4th, i. e., among the very best.

It should be remembered in considering the results of 1894, that it is not designed to draw any definite conclusions from these experiments till five successive crops have been grown, cured, sweated, and finally examined and graded by the expert. The fourth crop is now cased down for fermentation, and the fifth is to be grown in the summer of 1896.

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EXPERIMENTS IN GROWING TOBACCO WITH DIFFERENT FERTILIZERS. SEASON OF 1895.

By E. H. Jenkins.

These experiments are in continuation of those begun in 1892 in coöperation with the Connecticut Tobacco Experiment Co. of Poquonock in the town of Windsor.

Full particulars regarding the land, the conduct of the experiments and their results are given in the Reports of this Station for 1892, pages 1 to 24; for 1893, pages 112 to 144; for 1894, pages 254 to 284.

Fertilizers.

The fertilizers used in 1895 were sampled and analyzed by Messrs. Winton and Ogden, with the following results:

Composition and Cost of Fertilizers Used.

	Cost Per Ton.	Nitrogen.	Phosphoric Acid.	Potash.
Nitrate of Soda	$50.00	15.03	....	....
Cotton Seed Meal	22.00	6.65	2.35	1.73
Castor Pomace	15.00	5.04	4.18	1.81
Linseed Meal	27.00	6.29	1.66	1.24
Tobacco Stems	14.00	1.90*	.60*	8.10*
Cooper's Bone	28.00	2.24	26.65	....
Cotton Hull Ashes	45.00	....	7.04	2.41
Wood Ashes	10.40	....	2.43	4.28
High Grade Sulphate of Potash	50.00	....	....	50.39
Carbonate of Potash	170.00†	....	....	54.10
Double Carbonate Potash and Magnesia	39.00‡	....	....	18.10
Double Sulphate Potash and Magnesia	30.00	....	....	28.39
Fish	35.00	9.26	7.36	....

The chemicals used for each plot were accurately weighed and labeled by the Station representative, mixed thoroughly and bagged by Mr. DuBon and himself.

The bags were carried to the several plots by Mr. DuBon, and their contents were sowed under his constant supervision.

The following table shows the plan of the experiment, the fertilizers applied, with the cost of each as far as known, and the quantities of nitrogen, phosphoric acid and potash contained in them.

* Estimated. † By single pound; ton rates would be much lower

‡ Total cost of importing a one ton lot from Stassfurt.

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Fertilizers Applied, Season of 1895.

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds.		
			Nitrogen.	Phosphoric Acid.	Potash.
A	1579 Cotton Seed Meal 1297 Cotton Hull Ashes	$46.55	105	159	340
B	1669 Linseed Meal 1324 Cotton Hull Ashes	52.32	105	152	340
C	2631 Cotton Seed Meal 1221 Cotton Hull Ashes	56.41	175	177	340
D	3158 Cotton Seed Meal 1184 Cotton Hull Ashes	61.38	210	186	340
E	2083 Castor Pomace 1254 Cotton Hull Ashes	43.83	105	205	340
F	1669 Linseed Meal 536 Cotton Hull Ashes 277 Cooper's Bone	38.47	105	152	150
G	3472 Castor Pomace 1149 Cotton Hull Ashes	51.87	175	253	340
H	4166 Castor Pomace 1097 Cotton Hull Ashes	55.93	210	277	340
I	2083 Castor Pomace 1254 Cotton Hull Ashes 320 Nitrate of Soda* 320 Nitrate of Soda†	59.84	210	205	340
J	2083 Castor Pomace 1254 Cotton Hull Ashes 640 Nitrate of Soda*	59.84	210	205	340
K	1579 Cotton Seed Meal 1102 Double Sulphate of Potash and Magnesia 457 Cooper's Bone	40.29	105	159	340
L	1579 Cotton Seed Meal 1102 Double Sulphate of Potash and Magnesia 457 Cooper's Bone 300 Lime	42.27	105	159	340
M	1579 Cotton Seed Meal 621 High Grade Sulphate of Potash 457 Cooper's Bone	39.28	105	159	340
N	1579 Cotton Seed Meal 621 High Grade Sulphate of Potash 457 Cooper's Bone 300 Lime	41.26	105	159	340

* Applied between the rows at the time of first cultivation.

† Applied between the rows at the time of second cultivation.

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Fertilizers Applied, Season of 1894

Name of Plot.	FERTILIZERS APPLIED. Pounds per Acre.	Cost per Acre.	Fertilizer contains pounds.		
			Nitrogen.	Phosphoric Acid.	Potash.
O	1579 Cotton Seed Meal 578 Carbonate of Potash 457 Cooper's Bone	$72.90	105	159	340
P	1579 Cotton Seed Meal 1728 Double Carbonate Potash and Magnesia 457 Cooper's Bone	57.46	105	159	340
Q	2000 Baker's A. A. Superphosphate 4000 Baker's Tobacco Manure	....	240	453	434
R	2000 Stockbridge Tobacco Manure 500 Stockbridge Tobacco Manure*	....	154	307	278
S	3000 Stockbridge Tobacco Manure 500 Stockbridge Tobacco Manure*	....	215	430	389
T	945 Dry Ground Fish 547 Nitrate of Soda 300 Lime	32.19	175	70	....
U	2200 Mapes' Tobacco Manure, Wrapper Brand 600 Mapes' Starter	....	138	232	291
V	2400 Mapes' Tobacco Manure, Wrapper Brand 400 Mapes' Starter	....	143	219	309
W	2400 Mapes' Tobacco Manure, Wrapper Brand	....	130	165	296
X	2000 Sanderson's Formula for Tobacco	....	99	156	122
Y	1579 Cotton Seed Meal 7290 Wood Ashes	55.27	105	214	340
Z	1134 Dry Ground Fish 1197 Double Sulphate of Potash and Magnesia 283 Cooper's Bone	41.74	105	159	340
AA	Stable Manure 10–12 cords†	....	111	71	149
BB	6000 Tobacco Stems 2894 Castor Pomace	63.71	239	74	517
CC	3000 Pinney's Formula Fertilizer	....	131	196	305

* Applied as a starter.

† Estimated to contain 111 lbs. nitrogen, 71 lbs. phosphoric acid and 149 lbs. potash.

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Planting and Care During Growth.

The experience of previous years having showed that the plants were injured by contact with the fertilizers, if the latter were merely harrowed in, near setting time, in 1895 the fertilizers were plowed under, two weeks before the plants were set. The results were perfectly satisfactory. The plants started quickly, grew well and showed no signs of "burning" by contact with the fertilizers.

The plants were set with the Bemis planter on May 25th. Paris green was applied on the 27th, to check the ravages of the cut worm.

On June 3d, 2,000 plants were re-set.

On July 13th, about two thirds of the whole field was topped. On the 20th, all had been topped except plots T, Z and Y, which were backward in development. At this time the tobacco on plot AA was as large as any, but looked as if needing plant food. On the 25th, this plot of tobacco had begun to turn yellow. The crop was harvested on Aug. 14th and 15th.

Notes on the Rainfall, Soil Moisture and Temperature.

As in the season of 1893, through the coöperation of Prof. Milton Whitney, Chief of the Division of Agricultural Soils of the U. S. Department of Agriculture, who supplied the necessary instruments, daily observations were made by Mr. Adelbert DuBon during the growing season, of maximum and minimum air temperature (radiation thermometers), maximum and minimum soil temperatures (average to depth of nine inches), and rainfall.

The instruments were placed near the crop on a plot which was kept free from all vegetation.

Samples of soil to the depth of nine inches were also daily drawn by Mr. DuBon from several plots and sent to the Station for determination of moisture.

The sampling apparatus and method of packing the samples were designed by Prof. Whitney.

These observations taken together give a record of meteorological conditions which, however incomplete, is of great assistance in comparing the conditions under which the crops of successive years are raised.

Rain-fall in 1895.

The tobacco was set on May 25th, and harvested on August 14th and 15th, and was in the field therefore 81 days. The rainfall during that time was as follows :

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May 26	.22	July 1	.09	July 25	.10
" 27	.66	" 4	.50	" 27	.51
June 3	.30	" 5	.25	" 30	.30
" 6	.21	" 6	1.10	Aug. 7	1.20
" 25	.19	" 9	1.37	" 10	.06
" 27	.25	" 13	.74	" 12	.25
" 28	.48	" 16	.35	" 13	.09
" 29	.10	" 20	.06		

Total 9.38 inches.

The corresponding rain-fall in 1894 was 7.16 inches, in 1893 6.13, in 1892, 16.01.

On only nine days was the soil "too dry" in the opinion of the grower. In 1894, there were 15 such days. June was a dry month and no rain fell from the 6th to the 25th, but after this time more or less rain fell every week.

On the whole the season was more favorable for the crop as far as concerns rainfall than either 1893 or 1894.

The Percentage of Water in the Soil.

Daily determinations of moisture in the soil, taken to the depth of 8 inches, were made on three different plots of the field, as follows:—

Plot 1, after lying unfertilized and untilled for ten years, was plowed in 1894 and 1895, kept free from vegetation and the soil surface was occasionally stirred by raking.

Plots F and Y were planted with tobacco, the former dressed with 1670 lbs. to the acre of Linseed Meal, 536 of Cotton Hull Ashes and 277 lbs. of Cooper's Bone. Plot W was dressed with 2,400 pounds of Mapes' Tobacco Manure.

In the following table are given the average per cents of water found in the soils for each week, calculated from daily determinations.

Average Moisture in Tobacco Soil.

	Plot bare of vegetation.	Plots planted to Tobacco.	
	A	F	Y
June 17 to 23	7.4	8.6	6.3
" 24 " 30	8.5	9.8	7.8
July 1 " 7	8.5	9.9	9.1
" 8 " 14	10.6	11.7	11.3
" 15 " 21	8.6	9.7	8.8
" 22 " 28	8.5	7.6	5.6
" 29 " Aug. 4	7.9	6.4	7.2
Aug. 5 " " 11	8.2	8.3	6.8
" 12 " " 18	8.5	9.5	8.2
Average,	8.5	9.1	7.9

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In 1895, the plot which was bare of vegetation contained on the average one per cent. more of moisture than in 1894. Plot F, for some unknown reason, in both seasons has held more moisture than most of the plots.

In 1894 the plots planted to tobacco contained considerably less water after the crop had reached its full development than earlier in the growing season. In 1895, on the contrary, the rainfall was such as to keep the water-content of the soil practically the same throughout the growing season.

Temperature of Air and Soil.

Daily observations of temperature were made, as already described, by Mr. Adelbert DuBon.

In the following table are given the average weekly maxima, minima and ranges of temperature.

Air and Soil Temperature at the Tobacco Field.

Weekly Averages.

		Radiation thermometers.			Soil temperature.		
		Max.	Min.	Range.	Max.	Min.	Range.
June 18 to June 22		97	50	47	85	69	16
" 23 " " 29		87	60	28	84	65	19
" 30 " July 6		84	53	31	84	61	23
July 7 " " 13		83	52	31	87	60	27
" 14 " " 20		85	53	32	80	57	23
" 21 " " 27		92	53	39	93	70	23
" 28 " Aug. 3		84	49	35	86	60	26
Aug. 4 " " 10		93	56	37	94	69	25
" 11 " " 17		94	56	38	97	64	33
" 18 " " 22		84	49	35	92	59	33

The highest temperature recorded by the radiation thermometer was 102°, the lowest 41°.

The highest record of the soil thermometer was 101°, and the lowest 50°.

Harvesting, Curing, Stripping and Sorting.

The crop was harvested on Aug. 14 and 15. The weather was generally favorable for rapid and dry curing. There was no trace of pole-sweat in the tobacco, but some white vein. The crop cured too rapidly to get the best quality of wrapper leaf.

On Oct. 13th, the cured tobacco was taken from the poles and was stripped on the 14th and 15th.

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Sorting was begun on the 7th of November and required about a week for its completion.

At each handling of the crop a representative of the Station was always present; all weights were made and recorded and samples drawn by him.

As the crops were sorted, samples were carefully drawn from each lot of long and short wrappers and labeled as described in the Report for 1893, p. 138.

These samples were for laboratory examinations and for fermentation.

The following table gives the results of the sorting. The weights are in pounds. For those unfamiliar with the details of sorting leaf-tobacco, it may be said that the "seconds" are the lower leaves on the stalk, smaller than those of either of the other grades, over-ripe and unfit for wrappers. The "long wrappers" and "short wrappers" are the most valuable part of the crop, the latter being smaller and lighter, and often cutting to greater advantage than "long wrappers." The "top leaves" are often as large as the long wrappers, but heavier, darker in color and unripe.

WEIGHTS OF THE BARN-CURED LEAVES FROM $\frac{1}{10}$ ACRE.

CROP OF 1895.

Plot.	Long Wrappers.	Short Wrappers.	Seconds.	Top Leaves.	Net weight of Sorted Tobacco.
A	41½	11	13½	17	83
B	39	12	10	20½	81½
C	47½	16½	11½	15½	91
D	58½	15	10	17	100½
E	50½	15	10½	17½	93½
F	32	11	14	21	78
G	42½	14½	15	17½	89½
H	59½	13	8½	17½	98½
I	65½	13	8	15	101½
J	63½	16	7½	19½	106½
K	41½	13½	12½	19	86½
L	32	12½	19½	23½	87½
M	32	12½	17	26½	88
N	42	15½	13½	17½	88½
O	42	15½	10½	17	85
P	37	16½	10½	16½	80½
Q	45	10	14½	22½	92
R	40½	12	10½	19	82
S	55½	11½	8	15½	90½
T	29	7	15½	39	90½

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WEIGHTS OF THE BARN-CURED LEAVES FROM $\frac{1}{10}$ ACRE.

CROP OF 1895.

Plot.	Long Wrappers.	Short Wrappers.	Seconds.	Top Leaves.	Net weight of Sorted Tobacco.
U	48½	10½	14½	20	93½
V	39½	10½	13	14	77
W	42½	10½	9	13	74
X	50	10½	12	14	86½
Y	34½	13½	13	17½	78½
Z	35½	13	16	19½	84
AA	29	12½	19	18	78½
BB	62½	13½	8½	13	97½
CC	37	11½	13	19	80½

PER CENT. OF THE FOUR DIFFERENT GRADES.

POLE-CURED CROP OF 1895.

Plot.	Long Wrappers.	Short Wrappers.	Total per cent. of Wrappers.	Seconds.	Tops
A	51	13	64	16	20
B	48	15	63	12	25
C	52	18	70	12	18
D	57	15	72	10	18
E	54	16	70	11	19
F	41	14	55	18	27
G	47	16	63	17	20
H	60	13	73	8	19
I	64	13	77	8	15
J	60	15	75	7	18
K	47	16	63	14	23
L	36	14	50	22	28
M	36	14	50	20	30
N	48	17	65	15	20
O	50	18	68	12	20
P	46	20	66	13	21
Q	49	11	60	16	24
R	49	14	63	13	24
S	61	13	74	9	17
T	32	8	40	17	43
U	52	11	63	16	21
V	51	14	65	17	18
W	57	14	71	12	17
X	58	12	70	14	16
Y	44	17	61	16	23
Z	42	15	57	19	24
AA	37	16	53	24	23
BB	64	14	78	9	13
CC	46	14	60	16	24

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Comparative Fire-Holding Capacity.

Pole-cured Crop, 1895.

The method of determining the fire-holding capacity is described in the Station Report for 1892, page 17, and the meaning of the figures in the following table is described on page 140 of the present Report.

Plot.	Long Wrappers.	Short Wrappers.	Calculated from the average of both.	Plot.	Long Wrappers.	Short Wrappers.	Calculated from the average of both.
A	491	267	347	P	348	189	246
B	254	393	319	Q	189	129	150
C	337	282	292	R	250	228	227
D	291	390	332	S	159	280	218
E	352	465	399	T	152	100	117
F	283	275	266	U	174	195	178
G	237	349	288	V	162	221	188
H	291	179	217	W	241	316	271
I	256	254	244	X	100	108	100
J	226	272	241	Y	582	343	426
K	156	287	220	Z	293	233	248
L	287	244	251	AA	365	308	318
M	183	243	208	BB	321	236	260
N	185	267	221	CC	191	233	205
O	324	403	353				

Number of Pole-cured Leaves to the Pound.

Crop of 1895.

	Long Wrappers.	Short Wrappers.		Long Wrappers.	Short Wrappers.
A	57	78	P	65	83
B	53	78	Q	48	77
C	51	83	R	52	80
D	46	81	S	54	73
E	49	76	T	53	87
F	61	86	U	59	72
G	52	72	V	50	78
H	50	75	W	48	90
I	49	75	X	54	84
J	55	70	Y	59	87
K	54	85	Z	52	81
L	61	77	AA	63	70
M	57	69	BB	79	85
N	53	71	CC	58	81
O	62	82			

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Discussion of the Results.

The following paragraphs note the chief features of the crops of 1895. No strict comparison of them will be attempted till the crop has been fermented in the case.

Net Weight of the Sorted Crops, 1895.—The weights of sorted tobacco per acre, per cent. of wrapper leaves and weights of wrappers in the crops of 1892 and following years are:

Years.	Weight of Sorted Tobacco.	Per cent. of Wrappers.	Weight of Wrappers.
1892	1845	66.7	1231
1893	1559	48.5	756
1894	1713	62.1	1064
1895	1754	64.1	1124

Plots J, I, D, H and BB gave the largest yield of tobacco, from 2130 to 1950 pounds per acre, and also the largest yield of wrapper leaves, 1590 to 1450 pounds.

Plots W, V, F, Y and AA, yielded less than any others, from 1480 to 1570 pounds of leaf. The smallest yield of wrappers, however, was on plots T, AA, F, L and M, from 720 to 890 pounds.

Cotton Seed Meal and Castor Pomace.—(Plots A, C, D, compared with E, G, H.)

Between the gross yield of cured leaf from the plots dressed with cotton seed meal, and from those dressed with castor pomace was a difference of 140 pounds in favor of castor pomace; the difference in yield of wrapper leaf was but 100 pounds.

The weight of 100 leaves from the plots dressed with cotton seed was a little less than the weight of the same number of leaves from the castor pomace. As far as can be judged at present, there was no significant difference in the crops raised with these two fertilizers.

Increasing the quantity of cotton seed meal or of castor pomace applied to the land, from 1580 to 3160 pounds in case of cotton seed meal, and from 2080 to 4170 in case of castor pomace, increased the total yield and the yield of wrapper leaves.

Linseed Meal.—Plots B and F compared with A. The yield on Plot B, which was dressed with linseed meal instead of the corresponding quantity of cotton seed meal, was smaller than on plot A by only 30 pounds of leaves. No other differences between the two are noted.

On plot F, where the potash supplied was but 150 pounds instead of 340 pounds per acre as on plot B, the yield of leaves

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was 100 pounds less, and of wrappers 210 pounds less than on plot A.

Nitrate of Soda with Castor Pomace.—Plots I and J compared with plot H. Where, for an application of 210 pounds of nitrogen in form of castor pomace as on plot H, was substituted one-half that quantity of nitrogen in form of castor pomace, and the other half in form of nitrate of soda, plots I and J, the total yield of leaf and the yield of wrapper leaf were increased by about 150 pounds.

Fish, Stable Manure and Tobacco Stems.—Plot T, which was dressed with fish and nitrate of soda without potash, gave a very small yield of wrappers, 720 pounds per acre, with a very small capacity for holding fire. Plot Z, dressed with fish and double sulphate of potash yielded 250 pounds more of wrappers per acre.

The yield of wrappers on plot AA, dressed with 10–12 loads of stable manure per acre, was small, 830 pounds, while plot BB, dressed with tobacco stems and castor pomace, yielded 1520 pounds of wrappers.

Plot AA during the growing season showed signs of lack of plant food.

Potash Salts.—Plots A, K, L, M, N, O, P, Y. The nitrogen and phosphoric acid supplied to these plots in fertilizers has been the same in kind and quantity for four years.

The largest gross yields in 1895 from this series of plots were on M, high grade sulphate of potash, and N, high grade sulphate with lime, and were respectively 1760 and 1770 pounds of leaves.

The yield of wrappers, however, on M was as low as any, 890 pounds per acre, and on N 1050.

The yields of leaves on plots P, carbonate of potash and magnesia, and on Y wood ashes, were smaller than on A, cotton hull ashes; the others in the series were larger.

Plot O, carbonate of potash, gave the highest yield of wrappers, 1150 pounds, and plot K, double sulphate of potash and magnesia, came next, 1100 pounds.

The fire-holding capacity of the tobacco raised with high-grade sulphate was least in the series, that raised with the low grade sulphate was next.

The number of pole-cured leaves required to make a pound was also least in the leaves raised with the last two named forms of potash.

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THE NITROGEN AND MINERAL MATTERS IN A PEACH CROP.

By E. H. Jenkins.

Analyses by Messrs. Winton and Ogden.

A basket of peaches, raised at the Summit Orchard of Messrs. Platt and Barnes, West Cheshire, and bought in the New Haven market, has been examined at the Station laboratory.

The basket contained 151 peaches, which weighed 23.92 pounds,* or a little more than 2½ ounces† apiece.

2,000 grams of the fresh peaches were "stoned," sliced, air-dried and partially analyzed. The composition of the fruit was as follows, per cent. :—

Pulp or flesh, air-dry	11.85	containing	nitrogen	1.35
		"	ash	2.77
Stones or seeds, "	5.75	"	nitrogen	.88
		"	ash	.62
Water lost in air-drying	82.40			
	100.00			

Total nitrogen in air-dry fruit ..... 2.23 per cent.
" ash " " " ..... 3.39 " "

The ash of pulp and stones had the following composition :—

	Pulp.	Stones.
Sand and silica	6.38	5.26
Oxide of iron and alumina	.94	6.53
Lime	2.76	16.43
Magnesia	3.27	10.06
Potash	67.72	33.11
Soda	3.17	5.50
Phosphoric acid	11.60	18.92
Sulphuric acid	2.83	4.00
Chlorine	1.70	.21
	100.37	100.02
Oxygen equivalent of chlorine	.37	.02
	100.00	100.00

* Equal to 10,850 grams.

† Equal to 72 grams.

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When peach trees are set 18 feet apart each way, as is the common practice in this State, there are 130 trees to an acre.

Experienced growers reckon 3 baskets per tree, an average yield for orchards 5 years planted. Four baskets per tree is a maximum crop.

From the above data are calculated the quantities of nitrogen and mineral matters removed from an acre of 130 trees by the average crop of three baskets of peaches per tree, viz:

NITROGEN AND ASH-INGREDIENTS IN A PEACH CROP OF 390 BASKETS PER ACRE.

Nitrogen	19.7	pounds.
Potash	21.9	"
Soda	1.2	"
Lime	1.0	"
Magnesia	1.0	"
Oxide of iron	.4	"
Phosphoric acid	4.2	"
Sulphuric acid	1.0	"
Chlorine	.4	"

Contrary to the commonly received idea, the pulp of the fruit contains the greater part of both the nitrogen and mineral matters. Only about one-fourth of the nitrogen and one-tenth of the ash-elements are contained in the stones.

While these quantities of nitrogen and mineral matters are smaller than those removed by many other garden or field crops, it does not follow that peach trees need less care for their proper manuring.

The quantities of plant food required for the yearly growth of wood and leaves must be considerable. Young twigs contain a larger proportion of nitrogen, phosphoric acid and potash than old wood. But we have no exact data at hand from which to compute the yearly demand of the growing peach tree on the plant food in the soil.

Field experiments demonstrate that liberal fertilization is necessary to secure the most profitable returns from peach orchards.

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ON FERTILIZING ORCHARDS.

By S. W. Johnson.

The figures given in the foregoing paper, p. 158, simply show what is carried off from the acre of land by the crop of peaches and indicate that an annual return of 20 pounds of nitrogen, 22 of potash and 5 of phosphoric acid will restore to the land what the average peach crop requires, and that 27 lbs. of nitrogen, 30 of potash, and 7 of phosphoric acid will make good the deficit caused by a maximum crop, provided there are no other sources of loss besides the export of fruit. But it is one thing to return to the soil what the crop has removed and, to some extent, another thing to maintain the fertility of the soil so far as relates to the suitable supply of plant-food.

The active feeders of the tree in the soil are the young rootlets and root-hairs that are put forth the current year. The roots of five and two years ago are probably themselves totally incapable of feeding the plant. Even last year's roots are of little use except as they are a necessary basis of the new rootlets that develop this year. The young roots of each successive year of growth thus occupy different positions in the soil, and since most of the plant-food in the soil is incapable of movement, much of it, at any time, is out of the reach of the rootlets, and to be fertile the acre of soil must contain many pounds of plant-food in order to ensure to the crop the few pounds which the crop requires.

If the soil is very rich to begin with, the trees may produce well for years without fertilizers, but the New England hills which furnish our best orchard sites are now, as a rule, not fertile, and must be well enriched to make them profitable.

It is now, no doubt, well known to orchardists, that soils have the power of changing the solubility and availability of the plant-food which may be put upon them, in fertilizers. It is well-proved that phosphoric acid, applied in water-soluble form, shortly, in many soils within a few days or weeks, becomes quite insoluble in water, and for a considerable time gradually diminishes in availability. Certain soils contain enough phosphoric acid to serve many large crops if it were freely accessible to their roots, but that this phosphoric acid is not immediately available is demonstrated by the fact that moderate dressings of

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plain superphosphate strikingly increase the yield. What has just been stated of phosphoric acid is equally true of potash.

As to nitrogen, we know much but not nearly enough of its incomings and outgoings. We know that the soils of forests, meadows and moist pastures gain in nitrogen, while dry, naked or tilled ground loses nitrogen from year to year. We know that clovers and legumes generally, rapidly enrich or may enrich the soil they grow upon, as respects nitrogen, while the culture of cereals, root and fiber crops, and garden "truck," diminishes and exhausts the soil-nitrogen.

As a rule, in case of soils that have a fair proportion of fine, clayey matters, all the phosphoric acid and potash that may be needed to aid any crop, if once applied, cannot escape from the soil and will be retained near the surface, will not in any event descend much below or spread from where it has been placed. With nitrogen it is very different and loss of this element may occur in three ways: 1st, by leaching out, in the drainage-water, as nitrates; 2d, by escaping into the air, as nitrogen gas, and 3d, by conversion into comparatively inert forms, such as exist in leaf-mold, swamp-muck and peat (humus), or in the cell tissues of fungi and the shells or cases of insects (chitin).

For these reasons, soluble and active, and therefore costly fertilizers, are best applied in small doses, at or near the surface of the ground and at short intervals, while cheap, insoluble and slowly-acting manures may be used in large applications and deeply mixed in order to establish a more permanent state of fertility.

The amount of any needed fertilizer-element to be supplied annually, must be learned by experience or experiment, since soils vary greatly in their composition and qualities, and the supply must commonly be several or many times larger than the amount annually taken off in the crop.

One fertilizer-element that is scarcely noticeable in the export of the peach crop, is nevertheless important to its production. The chief ingredient of the ash of the wood, bark and leaves of all trees is generally lime. The wood of healthy peach twigs, of one year's growth, from the orchard of the late P. M. Augur, analyzed at this station (Annual Report, 1884, p. 93), contained 1.87 per cent. of ash, of which 54.2 per cent. was lime, 9.5 per cent. magnesia, 16.3 per cent. potash, 4.3 per cent. phosphoric acid and 6.9 per cent. sulphuric acid. The mature leaves of oak and

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chestnut trees contain, with about 30 per cent. of water, 3 to 4 per cent. of ash and of the latter 30–40 per cent. is lime. Where the water of wells or springs, coming from the soil, is soft or but slightly hard, the orchard needs lime to be supplied. This substance dissolves rather freely in the drainage water and is therefore subject to constant waste. In case of most Connecticut soils the natural supply of lime comes from rocks (boulders, gravel, sand and rock-dust) which contain but little and yield it up very slowly. For these reasons wood ashes or cheap lime should be broadcast at the rate of some 500 lbs. per acre, yearly.

If, as is becoming common, scarlet clover or other legume is sown to gather nitrogen, this dressing of lime and a liberal use of potash salts will probably be essential to the highest success.

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THE BEST ECONOMY OF CONCENTRATED FERTILIZERS.

By S. W. JOHNSON.

All plants commonly cultivated in the field or garden require to their full and profitable development the coöperation of a number of *agencies* or forms of energy, of *substances* or kinds of matter and of *conditions* or circumstances of situation. These agencies, substances and conditions *must work together* in due quantities and proportions, and the absence or deficiency of any single one, as well as too much of any one, will injure, destroy or prevent a crop.

The *agencies required* are on the one hand the radiant energy that comes to us primarily from the sun, which we call light and heat, and on the other, the forces that reside in the matter of air, water, soil and fertilizers—forces which are named chemical affinity, cohesion, adhesion, etc.

To what extent electrical energy is involved in crop-production is as yet but little understood. Latterly the agencies of microscopic life in the soil have been found to have an importance that but a few years ago was not dreamed of.

The *needed substances* are those which essentially compose fertile soil, perfect plants and animals and useful manures, viz: oxygen gas and carbonic acid gas of the air, water of air and soil, sand, clay and humus (or decaying vegetable matter) of the soil, and the several forms of plant-food which the productive soil is the source of—sulphates, phosphates, nitrates, carbonates and muriates of potash, ammonia, lime, magnesia and iron.

Among the *requisite conditions* are certain alternations of heat and cold, of light and darkness, of dryness and wetness, due porosity and compactness of soil.

Many farmers who live on a fertile soil and under a genial sky, even in these latter days, gather in their abundant harvests with little thought or knowledge of these energies and substances. The sun, the rain, the soil, prepared for them in the beginning, have been the sufficient sources of everything needed for their crops.

But most of those who will read these lines do so because, what in the beginning answered well enough for them or for their forerunners has become insufficient and they are compelled to make inquiry: What is the reason that crops are poor, and what

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can be done to the land to restore and increase its productiveness?

The commercial fertilizer commonly supplies to the crop several substances which are indispensable to its make-up and which, therefore, are adapted to assist its growth, principally nitrogen, phosphoric acid and potash. With these, lime, magnesia, chlorine and sulphuric acid are frequently associated. The three substances first-named are also those which, in general, are most rare in the soil; which, therefore, are most quickly exhausted and most difficult and costly to restore.

When land is infertile, because it is deficient in one or more of the ingredients of commercial fertilizers, then the use of the latter is the certain and proper remedy, as experience on the part of thousands of farmers in Europe and America has thoroughly demonstrated.

But the commercial fertilizer does not, in most cases, fully restore what the crop removes, and as the land, by a long series of harvests, has once been reduced to a comparative infertility which the superphosphate or potash salt or nitrate has relieved, so it will in time, if cropped by their help alone, fail again because some substance or condition which they have not supplied has been exhausted or destroyed.

The solar energies that develop our crops are furnished, in the course of nature, in such plenitude as, we well understand, belongs to our climate and to the exposure and situation of our fields. We cannot increase the sunshine either in its duration or intensity. We can, however, more or less neutralize and nullify its good offices or fail to get the full measure of its benefits by leaving our originally wet fields water-soaked, or by permitting them to pass into a springy and stagnant condition. The heat of the sun, without which the soil is incapable of affording a genial rooting-place to our crops, cannot find its way downward to give due warmth to the earth unless there is free circulation of water in the soil, nor can the abundant oxygen of the air, without which no part of any plant can grow or live, be supplied to the roots of our crops unless the soil has a proper porosity and openness of texture established and maintained in it by judicious tillage and, it may be, by drainage or other amendment.

It is true enough, that in many instances a few hundred pounds of superphosphate or bone-dust, or sulphate of ammonia or a combination of them, has enabled a field to yield better harvests than could be got by a more costly application of stable or yard

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manure. This is plainly because the manure alone could not supply enough of nitrogen or of phosphoric acid or of potash for the crop. It is also true, that in many cases the commercial fertilizer which, for a few years, far outdid the stable manure, finally fails to perform the duty expected of it and the stable manure must be had recourse to and gives satisfaction, save in respect to the trouble and cost of getting it. This, again, is because the stable manure supplied something which the commercial fertilizer could not.

That "something" in some cases is a substance or kind of matter—it may be lime, which in the course of cropping is removed from the soil in larger quantity than commercial fertilizers supply, or potash, which is often wanting in superphosphates; but in most cases it is a "condition," a "texture" of the soil which is not easy to describe, but which in the dunged land is recognized as a mellowness and moistness that is lacking in the land not dunged.

The garden of the Connecticut Agricultural Experiment Station is a coarse, sandy loam, which with moderate dressings of decaying vegetable matter in shape of stable manure has the texture, feel and look of good land and gives good crops, but without a supply of humus soon becomes harsh and "worn out."

A little of the spongy matter of dead and rotting manure, a little of the gelatinous "Geine" of the author of the "Muck Manual," gives to soil a quality which enables the earth to serve as an efficient regulator of the heat and moisture that have or should have access to it.

Reference has been made to the fact that lime is supplied to the land in small quantity by superphosphates. It may be added that they furnish lime mostly as phosphate or sulphate. The well authenticated result of experience, in British agriculture, some forty years ago, that "lime had reclaimed more poor land than all other fertilizers put together," is a practically acquired fact, demonstrating that application of carbonate of lime (or quicklime which rapidly becomes carbonate) in many cases makes land fertile by supplying one or several "conditions" favorable to crops. We have of late years learned in what some of these conditions consist. We know that when muriate of potash and sulphate of ammonia are given to growing crops the potash and ammonia are appropriated by the plant while the muriatic acid and sulphuric acid are left in the soil. Now that they shall not accumulate in such quantity as to injure vegetation it is essential

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that the soil contain some substance, itself harmless, which shall take up and neutralize the liberated acids. Carbonate of lime is one of the best materials for this purpose and on the soil of regions where lime is naturally deficient (which is the case where well- and spring-waters are "soft") the farmer should lose no good opportunity to add moderate quantities of carbonate of lime to those of his fields upon which he has made or intends making extensive use of potash or ammonia salts, or of fertilizers containing them.

Again, we understand that the conversion of refuse vegetable and animal matters—such as stable-manure, leaf-mold, the stubble of crops, dried blood, tankage, hair and wool waste and the organic matter of bone—into plant-food, requires the intervention of chemical agencies which shall transform their inert nitrogen into ammonia-salts or nitrates. The natural forces that do this work, and do it most cheaply and beneficially, are those of the microbes (small life) which the most powerful microscopes just enable us to see, organisms that feed upon these refuse matters in the soil. The nitrifying microbe, which changes agriculturally inert nitrogen into nitrates, cannot perform its work in a soil where any considerable amount of free acid other than carbonic acid exists, but works well and multiplies in presence of a little carbonate of lime.

Space is wanting here to go further into this subject and my purpose is simply to illustrate the fact that the interests of those who buy as well as of those who sell commercial fertilizers can be best promoted by a knowledge, well applied, of all the factors of crop-production; that the plant, like the man, to flourish, not only requires an abundant and varied bill of fare, but also a suitable lodging and the comforts of a well-appointed home; that the best economy of commercial fertilizers is to be attained by intelligently investigating what special wants of the soil or crop their various grades are adapted to meet, and what further wants of soil or crop must be attended to in order to prevent that impoverishment of land and landholder which otherwise, sooner or later, is likely to ensue—the experience of which has led many agriculturalists to the erroneous conclusion that concentrated fertilizers are "stimulants and not nourishment," and that they "exhaust the soil," whereas they merely aid the farmer to exhaust the soil by rapidly removing, in the crops, substances which the soil unaided can supply but slowly or insufficiently and by impairing or destroying one or several of those conditions which are indispensable to plant-production.

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FURTHER EXPERIMENTS ON THE PREVENTION OF POTATO-SCAB.

By Wm. C. Sturgis.

The results of the experiments conducted at South Manchester during the summer of 1894 clearly demonstrated the value of treating "seed"-potatoes with corrosive sublimate. Incidentally the results indicated the value of certain minor precautions. The use of clean seed, that is, seed free from scab, is to be strongly recommended, inasmuch as the amount of scab on the crop was found to be directly proportional to the amount of scab on the seed. There was strong evidence that the use of barnyard manure tends to increase the amount of scab on the crop, other things being equal, an effect which cannot be entirely counteracted by the corrosive sublimate treatment. These results harmonized with those obtained by other observers, and seemed conclusive as far as they went. One very important factor however, was disregarded in the experiments. The land itself was free from the germs of the scab-fungus, having been in grass for a number of years, and having never probably borne a root crop; the freedom from scab which resulted from the planting of clean seed, treated before planting with corrosive sublimate, might very probably therefore have been due in a measure to the fact that there was no source of infection in the soil. It is usually either impossible or impracticable to secure such a soil-condition on the farm, and it was therefore necessary to repeat the experiment under the conditions obtaining in general farm practice. The previous experiment had brought about the required condition. The smallest percentage of scabby potatoes obtained from any one plot in 1894 was 16 per cent. on plot H. The other plots yielded from 23 to 84 per cent. of scabby potatoes. At the close of the experiment therefore, the whole piece was infested with the scab-fungus in various degrees, and the percentage of scabby potatoes obtained respectively from each plot served as a basis for determining in a general way the comparative quantity of the scab-fungus in the soil of that particular plot. Thus it was not only known that the land contained the germs of the disease, but it was also possible to estimate roughly to what extent this condition might be expected to affect the coming crop on any partic-

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ular portion of the field. In order to have a basis of comparison between potatoes grown on land infested with scab and on land free from scab, a new piece immediately adjoining the old was ploughed under in the autumn and prepared for planting; this land was practically free from scab except where it joined the old piece. Here it was doubtless contaminated, as the whole piece, including the new land, was ploughed and harrowed in the spring in a direction at right angles to the former rows.

In 1893 and 1894, the Rhode Island Station undertook a series of experiments with the view of ascertaining the effect of lime in increasing or diminishing scab upon potatoes.* These experiments are interpreted as showing that air-slaked lime tends to increase the scab of potatoes if applied to land which is naturally acid, this action being attributed to the production by the lime of a neutral in place of an acid condition of the soil, and the fact that the scab-fungus thrives best in a medium which is neither strongly acid nor strongly alkaline. Inasmuch as it had been generally supposed that lime, wood-ashes, or other alkaline substances always tended to increase scab, no matter what the soil-conditions, the results obtained in Rhode Island are valuable, and it seemed advisable to include in our experiment at South Manchester some inquiry into the matter. It should be borne in mind however, that the Rhode Island soils are said to be very acid, while that of our experimental field is not considered "sour."

Finally, information was desired upon the effect of barn-yard manure as regards the prevalence of scab. To obtain this, another piece of new land immediately adjoining the old was prepared and heavily manured.

The subjoined plan (Table I, p. 168) shows the divisions of the field at the beginning of the experiments. The portion enclosed by solid lines represents the land used in the experiments of 1894, the broken lines indicate the new land used for the first time in 1895. The limits of plots A–H were the same in both experiments; the numbers of rows in each plot are given on the plan, the rows being numbered consecutively from A; and the estimated percentage of scab in each plot is also shown.

For the experiment of 1895, the whole field, including the new land, received an ordinary dressing of commercial fertilizer.† To

* R. I. Agr. Exp. Sta., Bull. 26, Nov. 1893; and Bull. 30, Nov. 1894.

†Applied at a rate to the acre of 1200 lbs. cotton-seed meal, 300 lbs. muriate of potash, and 500 lbs. dissolved South Carolina rock.

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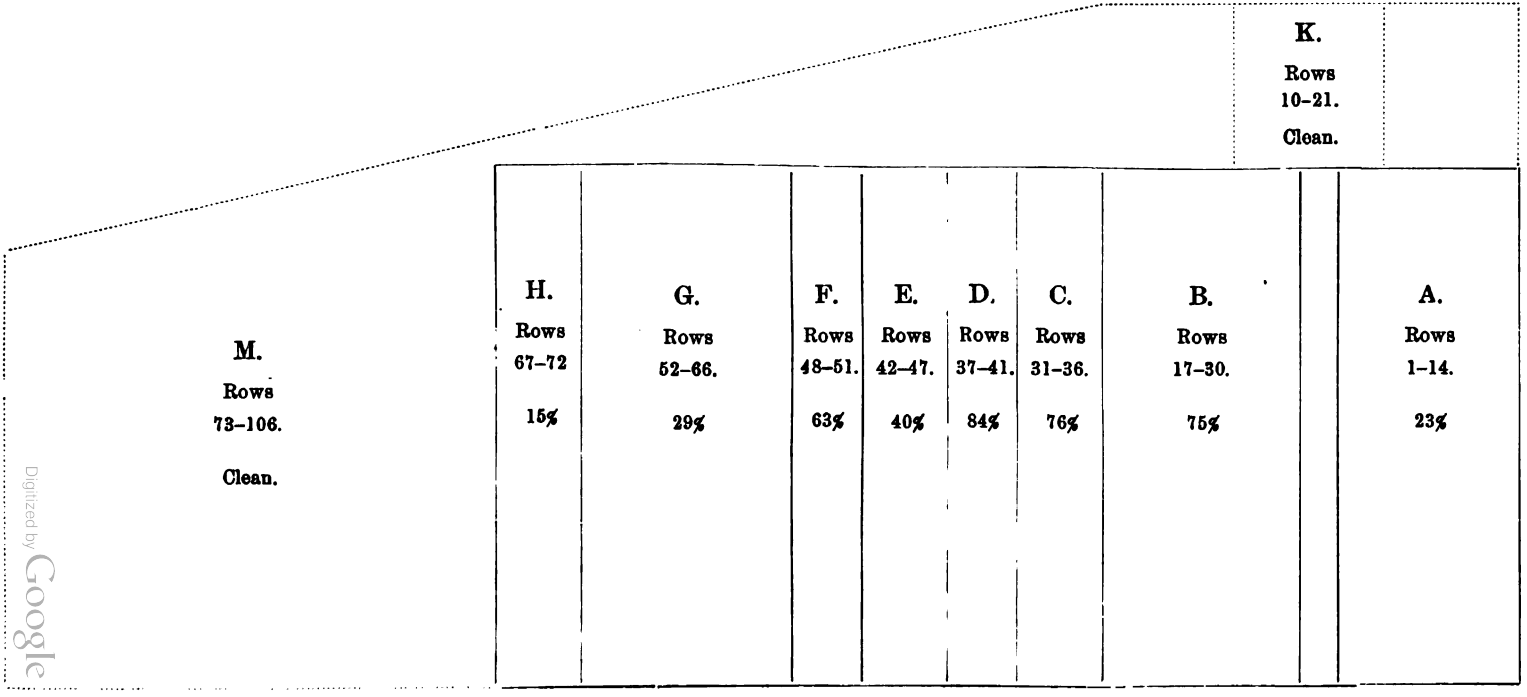
TABLE I.—PLAN OF EXPERIMENTAL FIELD OF POTATOES AT SOUTH MANCHESTER, CONN.



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test the effect of lime, plot A was divided into two portions, one of which received a top-dressing of air-slaked lime with the fertilizer at the rate of one-half ton to the acre, while the other received no lime. A portion of each of these two half-plots was planted with treated seed, and the other with untreated. The seed-potatoes used throughout the whole experiment were clean.

Between A and B were planted two rows of seed which had been sprouted in order to test the effect of corrosive sublimate on the vitality of the sprouts. The latter were from one to three inches long at the time of planting. Plots B, D, F, G and H were planted with treated seed, i. e., with seed which had been soaked one and one-half hours in a solution of two and a quarter ounces of corrosive sublimate (bi-chloride of mercury) in fifteen gallons of water, then cut and planted as usual. Plots C and E were planted with seed not so treated, but in every other regard the same. The greater part of plot M was planted with treated seed, but a few rows received untreated seed for purposes of comparison.

Finally, plot K was divided into two parts of six rows each. One of these received fresh barn-yard manure, the other well-rotted compost from the same source. Each of these materials was applied in two different ways—in direct contact with the seed, and separated from the seed by a layer of soil. Plot K therefore, comprised four sub-plots illustrating the effect of (1) raw manure in direct contact with the seed, (2) raw manure not in contact with the seed, (3) composted manure in contact with the seed, and (4) composted manure not in contact with the seed. In order that any results which were obtained might be reasonably attributed to the presence of the manure or to the method of its application, the seed used on plot K was selected for its freedom from scab, the land was clean, and the seed received no preventive treatment.

From the plots so arranged and treated, information was expected on the following points :

1. The effect of lime on the prevalence of scab in a fairly neutral soil infested with scab and planted with clean seed, both treated with corrosive sublimate and untreated. (Plot A.)

2. The effect of corrosive sublimate on the vitality of sprouted seed-potatoes. (Two rows between plots A and B.)

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3. The effect of treating seed-potatoes with corrosive sublimate in preventing scab upon land infected by a previous crop of scabby potatoes. (Plots B–G.)

4. The effect of the same upon clean land. (Plot M.)

5. The effect of barn-yard manure, both fresh and composted, in inducing scab upon potatoes grown from clean seed on clean land.

A few words may be of interest regarding the conditions of growth. The potatoes were all planted May 17th and 18th, and by June 15th were making fine growth. The plants from the sprouted seed were about a week in advance of the others, and maintained their advantage throughout, although those fertilized with fresh manure were not far behind them. From June 6th to June 20th the weather was exceptionally dry, but abundant rains had fallen previously and the vines received no serious check from drought during the season. They were all thoroughly sprayed with Bordeaux mixture on July 19th, but blight appeared notwithstanding, and by the beginning of August its effects had become very serious. A second application of Bordeaux mixture on August 12th failed to check the blight. As far as the experiment was concerned however, there was no serious injury, as all the experimental rows with one exception were planted with the variety New Queen, which proved remarkably resistant to the blight. The other varieties, Polaris, Woodbury White, and Early Rose proved very susceptible, and by the middle of August were half dead. All of the potatoes were dug Oct. 9th.

As in the experiment of last year, one or more sample rows were taken from each plot, the tubers were cleaned and separated with the greatest care into three grades according to the amount of scab visible upon them, grade I including tubers free from scab, grade II tubers fairly scabby but marketable, and grade III tubers rendered unmarketable by scab. After sorting, the product in each grade was weighed, measured, and photographed. The same process was applied to the sample yield from each plot.

Referring now to Table II, p. 171, we see that, leaving out of consideration for the present the treatment of the seed, the use of lime has increased the percentage of scab. The two rows which received lime show an average of over 34 per cent. of scabby potatoes, while those which received no lime show somewhat less than 21 per cent.

The results following the treatment of the seed on plot A are not without interest. The difference between the percentage of

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TABLE II.—RESULTS OF EXPERIMENTS ON POTATOES AT SOUTH MANCHESTER, CONN.

Plot.	Sample row.	Fertilizer.	Scab in land.*	Treatment of Seed.	Weight of Crop.	Quality of Crop.	Total Per Cent. of Scab.
A^1	No. 3	Commercial with Lime	23%	Corrosive Sublimate	111 lbs.	1. 77 lbs. = 69% 2. 29 " = 26% 3. 5 " = 4.5%	30.5%
A^2	No. 5	Commercial with Lime	23%	0	106 lbs.	1. 66 lbs. = 62% 2. 36 " = 34% 3. 4 " = 4%	38%
A^3	No. 11	Commercial without Lime	23%	Corrosive Sublimate	102.5 lbs	1. 78 lbs. = 76% 2. 22.5 " = 22% 3. 2 " = 2%	24%
A^4	No. 13	Commercial without Lime	23%	0	92 lbs.	1. 75.5 lbs. = 82% 2. 14.5 " = 16% 3. 2 " = 2%	18%
Sprouted seed	No. 15	Commercial	49%	Corrosive Sublimate	124 lbs.	1. 90 lbs. = 76% 2. 32.5 " = 26% 3. 2 " = 2%	28%
D & G	Nos. 39 & 60	Commercial	56%	Corrosive Sublimate	191 lbs.	1. 122.5 lbs. = 64% 2. 65.5 " = 34% 3. 3 " = 2%	36%
C & E	Nos. 32 & 45	Commercial	58%	0	233.5 lbs.	1. 133 lbs. = 57% 2. 92.5 " = 39.6% 3. 8 " = 3.4%	43%
M^1	No. 76	Commercial	0	Corrosive Sublimate	88 lbs.	1. 72 lbs. = 82% 2. 16 " = 19% 3. 0 " = 0	18%
M^2	No. 78	Commercial	0	0	107.5 lbs.	1. 81.5 lbs. = 75.8% 2. 25 " = 23.2% 3. 1 " = .9%	24.1%
K^1	Nos. 10–15	Barnyard manure (Composted)	0	0	297.5 lbs.	1. 173 lbs. = 58.2% 2. 91.5 " = 30.7% 3. 33 " = 11.1%	41.8%
K^2	Nos. 16–21	Barnyard manure (Fresh)	0	0	226.5 lbs.	1. 189.5 lbs. = 83.7% 2. 31 " = 13.7% 3. 6 " = 2.6%	16.3%

* Comparative estimate of scab-infection based on per cent. of scabby potatoes in crop of 1894, see page 166.

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scab in rows 3 and 11, the seed for which was treated, and rows 5 and 13, which were not treated, is hardly appreciable. In fact all the plots occupying the infested land show similar results. In no case is the showing so markedly favorable to the treatment as in the experiments of 1894, where all the land was clean and the scabby seed served as the only means of infection. The conclusion seems inevitable that the prevalence of potato-scab is largely due to the prevalence of the germs in the soil, and under these conditions the treatment of the seed with corrosive sublimate loses much of its efficacy. Such a conclusion was to be expected. When the germs of the fungus are largely confined to the seed-potato itself, any treatment which will kill all or most of the germs will tend to produce a clean crop if the growing tubers are not infected from the soil or the manure. If, on the other hand, the germs exist throughout the soil, it is inconceivable to suppose that tubers formed even a few inches from the seed would be materially affected by any substance applied to the seed. The uniform results of these experiments tend to confirm the impression that potatoes, even if previously subjected to a disinfecting treatment, should not be planted on land infested with the scab-fungus. For the purpose of testing the effect of corrosive sublimate on the vitality of sprouted seed-potatoes, two rows between plots A and B were selected. The seed-potatoes were spread out in a warm, light attic, where they readily sprouted, producing slender shoots from one to three inches in length. For practical purposes it would have been better to have sprouted the seed under conditions of warmth and sunlight, which would have produced a short and stocky growth. The comparatively long shoots are very delicate and are liable to become broken off in the necessary handling. The sprouted potatoes enclosed in a sack were immersed for one and one-half hours in the corrosive sublimate solution, then dried, cut, and planted, and by exercising care in handling, very few of the sprouts were lost. That the sprouts were uninjured by the treatment was indicated by their fresh and sound appearance an hour or more after the potatoes were removed from the solution, and by the fact already mentioned that throughout their period of growth they were a week in advance of potatoes planted in the ordinary way. A comparison of the yields is also interesting. The yield from one row of sprouted seed 105 feet long, amounted to 124½ lbs.; that from an average row of the same length, of unsprouted seed, amounted to 102½ lbs. The

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difference is over one-third of a bushel. Upon an acre, the increased yield would amount to about fifty-one bushels, an item certainly worth considering. As regards the effect of the treatment upon the scab, the only row with which the sprouted potatoes can be fairly compared is row 13. The comparison shows an advantage of ten per cent. in favor of the treatment, notwithstanding the fact that the land occupied by the sprouted potatoes presumably contained more than double the percentage of the scab-fungus. These figures however, regarding the scabbiness of the soil on the various plots are not to be considered as more than a rough appraisal, since even if we allow that the percentage of scab upon matured potatoes is a fair estimate of the percentage of germs remaining in the soil, many factors such as drainage, cross-cultivation, etc., tend to produce uniformity of soil conditions in adjacent plots. The figures are of value merely as an indication of the more or the less scabby condition of the soil in the respective plots.

For obtaining results on the third point—the effect of the treatment in preventing scab upon infested land—it was necessary to take two rows of treated seed and the same of untreated seed in order that the soil conditions might be as nearly as possible identical so far at least as the prevalence of scab was concerned. Plots D and G combined showed an average of 56 per cent.; the product of one row from each of these plots might therefore be justly compared with that of one row from each of the plots C and E, which together averaged 58 per cent. Although the percentage of scab upon the crop in both of these cases is very high (36 and 43 per cent.), the difference between them of 7 per cent. is in favor of the treatment, and the percentage of very scabby potatoes, though small in both cases, is almost twice as large in the untreated as in the treated rows. Furthermore, if we compare the quality of the crop from rows 39 and 60 on the one hand, and from row 76 on the other, the result of planting potatoes upon scabby land is rendered still more apparent. Although the seed in both instances was clean, was subjected to the same preventive treatment, and received the same application of commercial fertilizer, the gain in favor of the clean land amounts to more than 17 per cent. It will also be noted that the seed on the clean land of plot M, when treated, produced no very scabby potatoes, and it is doubtful if 5 per cent. of the tubers classed as grade II would have exhibited any trace of scab except to the eye of an expert.

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We may feel assured that, so far as it goes, there is abundant evidence that land infested with scab will produce a scabby crop even when every other condition favors a clean crop, and the seed has been treated thoroughly with corrosive sublimate. The treatment however, does tend in a definite though small degree, to diminish the percentage of scab upon tubers grown on slightly infested land.

The effect of the treatment upon potatoes planted on clean land is illustrated by rows 76 and 78, both being included in the new plot M. This matter was dwelt upon at length in our Report for 1894, and owing to the undoubted infection of plot M from the adjacent plot, the results are not sufficiently reliable or striking to merit further notice.

Finally, we may consider the effect of the barnyard manure. The question is important since the evidence of the experiments of 1894 in this direction has by some been considered inconclusive, and because many inquiries have been addressed to the Station regarding the effect, in this connection, of barnyard manure in different stages of decomposition. To test this matter, a piece of clean land on the west border of the original field was prepared.* Clean seed, which had received no treatment, was planted in twelve rows, each 33 feet long, continuous respectively with rows 10–21 of the old piece. The plot is represented by the division marked K on the field-plan. The use of clean seed and clean land secured conditions of practical immunity to the crop, except from germs conveyed to the land with the fertilizer. In six of the furrows, barnyard manure, freshly dropped and mixed with a small amount of litter, was used as a fertilizer; in the remaining six rows, manure from the same source, but composted for a year, was used. Each of these lots of six rows was divided into two smaller lots of three rows each, in one of which the seed was placed in immediate contact with the manure, both above and below, and in the other was separated from the manure by a layer of soil. This difference in the method of applying the manure exerted no appreciable influence upon the growth of the plants or the prevalence of scab, and in tabulating the results the condition of the manure itself was alone considered.

As has been said before, the plants on plot K were in advance of those on the remainder of the field, with the exception of those

*This new piece received an application of commercial fertilizer in common with the old piece, at the same time, and in the same proportions.

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from sprouted seed, and they maintained this advantage throughout the season. The tops made a very remarkable growth, and remained green for some time after those of the same variety (New Queen) on the rest of the field were practically dead. The yield exceeded that from the old piece by an amount equivalent to about sixty bushels to the acre. It must be remembered however, that plot K received a heavy application of manure in addition to the commercial fertilizer applied to the whole field, including plot K; this may be sufficient to account for the increased vigor of the plants and the proportional increase of the yield.

'But a matter of more importance at present is the effect of the composted manure as compared with the fresh, in inducing a scabby condition of the crop. The results show that the use of composted manure as compared with fresh manure has increased the amount of scabby potatoes by 25.5 per cent., and if we consider the very scabby tubers only, the difference is still more marked. It is impossible at present to account satisfactorily for this result, and with only the results of this experiment at hand it would be unwise to conclude hastily that fresh manure is always less liable to induce scab than manure which has been composted for a year or more. Many factors enter into the consideration of such a question. Manure from the same barnyard may show differences within a twelve-month as regards its scab-inducing quality; the feeding of scabby potatoes to live-stock might produce a manure which would insure the prevalence of scab on any land to which it was applied, while a change of feed a few months later might render manure from the same source entirely harmless. It is unwise to speculate upon the results of a single experiment. Should future experiments prove what in this instance has been indicated, i. e. that composted manure has a greater inherent tendency to favor the development of potato-scab than manure freshly dropped, the fact will be one of importance in cases where it would be more practicable to draw the manure directly from the barnyard to the field than to compost it and hold it over for one season.

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SUMMARY.

The experiments of 1895 upon the prevention of potato-scab indicate the following points:

1. That the addition of lime in small quantities to the soil of our experimental field, increased the amount of scab upon the potatoes. We are not prepared at present to offer any explanation of this fact.
2. That the presence in the soil of the germs of the scab-fungus tends so markedly to infect the coming crop that it is highly inadvisable to plant such land with potatoes, beets, or turnips.
3. That in case the soil is infested with the germs of the scab-fungus, the treatment of the seed with corrosive sublimate is of but little avail in preventing scab upon the crop.
4. That fresh barnyard manure exhibits less tendency to induce scab than composted manure. It cannot be too strongly emphasized however, that great stress must not be laid upon the result of our single experiment, since practically nothing was known regarding the infectious character of the particular manure used.

We hope to continue these experiments another year.

TRANSPLANTING, AS A PREVENTIVE OF SMUT UPON ONIONS.

BY WM. C. STURGIS.

There is no doubt that of the various fungous troubles of onions, the one known as "smut" and caused by the fungus *Urocystis Cepulæ* is by far the most serious. The rapid spread and disastrous nature of its attacks, the remarkable vitality of the germs or *spores*, and the persistence of the fungus in soil once infested with it, have combined to render worthless for onion culture many tracts of land in this State which formerly produced large crops. The fungus, its life-history, and its effects upon onions, have been ably discussed by Thaxter*, and for details the reader is referred to his work. Two methods of raising onions have long been practiced by Connecticut growers; one directly from seed, the other from small onions of the previous year's growth called "sets." As long as onion-smut has been recognized as a serious disease, it has been observed that onions raised from sets remain free from the disease even upon

* Annual Report of this Station for 1889, pp. 127–153.

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fields where onions raised from seed always suffer more or less seriously. Thaxter first suggested a sufficient reason for this fact, and proved his point by an ingenious experiment. He demonstrated that the smut fungus enters the onion seedling only while the latter is beneath the surface of the ground, so that if growth starts above ground, as in the case of sets, the plants are not affected with smut. The fact of the immunity, for the same reason, of transplanted seedlings was mentioned by Thaxter in this connection, but so far as I know the matter has received no practical demonstration. The method of growing onions by starting the seed in hot-beds, and transplanting the seedlings to the field, was suggested in 1891 by Mr. T. Greiner of La Salle, N. Y., and has since been practiced by him and by others with marked success. Several of the Experiment Stations also have tried this method. But all of these experiments have had for their object increase in the size and value of the onion crop. As far as that was concerned they were successful in proving that larger yields are obtained at no greater expense, and that the onions are larger and mature earlier than onions grown from seed sown in the open. But it seemed more than likely that this method would have another important advantage in producing a sound crop of onions even upon smutty land. Through the generous coöperation of Messrs. C. Buckingham and N. H. Sherwood of Southport, there was placed at the disposal of the Station a piece of land known to be infested with smut. The variety selected for the test was Wethersfield Red, and on March 6th the seed was sown in flats in Mr. Sherwood's greenhouse. Early in May the land was carefully prepared, and on the 8th of the month seed of the same variety and from the same package as that sown in flats, was sown in drills one foot apart, in the field. This could have been done earlier with profit, and the crop would doubtless have made a better showing. Between every two rows of seed, a space 3 ft. wide was left for the reception of two rows of seedlings. The latter were lifted from the flats on May 13th, and at once transplanted to the vacant rows. At this time the seedlings were half as thick as a lead-pencil and about 5 in. high. The soil was extremely dry, and a hot sun caused the plants to wilt badly, but they were watered that same evening and in a few days had recovered and were making a good growth. The plants were set in holes three inches apart, made by means of a narrow board set with wooden pins

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and pressed down with the foot. As fast as the holes were made, a man followed with the seedlings, dropping one in each hole and pressing the earth about it. The pins were of such a length that when the plants were set, the bulbs were about half an inch below the surface of the ground. From this time on the whole piece received the same treatment, being cultivated and weeded as usual. The transplanted rows however, required one less weeding than the rows from seed, and of course did not require thinning.

All of the onions were harvested on September 4th. There were 20 rows grown by each method, each row being 26 ft. long. The onions were carefully examined as they were pulled, and all smutty plants and scallions were put on one side. It was then found that about 10 per cent. of the onions from seed were smutty, and fully 15 per cent. were scallions. Had the onions been thinned, the percentage of scallions would doubtless have been smaller; but on the other hand, there was abundant evidence throughout the rows, that many of the plants had been affected with smut so early that they failed to grow, the places where they had been being marked by scanty, smutted remains of leaves and bulb-scales. The 10 per cent. of smutted onions mentioned above includes only those which reached a fair degree of maturity. The contrast on the transplanted rows was very striking. Not a single plant showed any trace of smut; less than 1 per cent. of the seedlings had failed to reach maturity, notwithstanding the fact that they were very small when transplanted and were subjected to a period of very dry weather immediately after being set; and only a trifle over 1 per cent. of the plants were scallions. (See Table III, p. 179).

It seems fair to conclude therefore, that by raising seedlings in flats, and transplanting to the open ground, a clean crop of onions can be grown even upon land thoroughly infested with smut. I am not yet prepared to recommend this method for adoption on a very large scale, though by many it is contended that the increased yield, larger bulbs, and less labor incident to weeding and thinning, more than compensate for the added labor and expense involved in raising the seedlings under glass and transplanting. I am convinced however, that under certain circumstances this method would be highly profitable. As will be shown presently the yield is greater, the bulbs are larger and more perfect, and the crop matures earlier, by the transplanting method than by sowing

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Table III.—Results of Experiments on Onions at Southport and at the Experiment Station.

Experiment at Southport.

Plot 39 ft. x 26 ft.

	Weight.	Quantity.	Av. Circumference.	Per cent. Smutted.	Per cent. Scallions and Missing.	Remarks.
20 rows Transplanted.	387 lbs.	6 bu. 1 pk.	8.24 in.	0	2%	
20 rows Seed.	212 lbs.	3 bu. 2½ pks.	4.98 in.	10%	15%	The actual percentage of smutted onions on these rows was much larger than appears, since many of the plants were completely destroyed. See p. 178.

Experiment at Station.

Plot 29 ft. x 10 ft.

14 rows Transplanted	81 lbs. 8 oz.	7½ pks.	6.8 in.		5%	The soil on this plot was poor and ill-adapted to onions; all of the bulbs were consequently small.
7 rows. Seed Thinned.	4 lbs. 15 oz.	½ pk.	3.4 in.		40%	Most of the loss on the 14 seeded rows was caused by cut-worms. The transplanted rows were practically untouched by worms.
7 rows. Seed Not Thinned.	11 lbs. 2 oz.	1 pk.	2.8 in.		40%	

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in the open; the former method therefore, will be of advantage where an acre or less is to be planted with onions for home consumption or for small sales. This method presents the advantage over sets that, whereas the labor and expense is practically the same in both cases, the transplanting method produces mature bulbs in the course of one season with only the initial expense of sash for the hot-bed. Transplanting might therefore, with increasing profit, supersede the use of sets. Finally, if for any reason it becomes necessary for a grower to use smutty land for onions, or if smut has recently made its appearance in a piece of onion land, the land so infested can be set with seedlings which will produce a clean crop, thus not only making smutty land once more available for onions, but lessening the danger of spreading the disease.

Although considerations regarding the comparative value of different methods of cultivation are rather horticultural than mycological, it seems advisable to note certain facts which this and other similar experiments have made apparent.

The general opinion seems to be that the large foreign varieties of onions show a greater gain from transplanting than the native varieties which are mainly used in Connecticut. It is not unusual for such varieties as White Tripoli, Rocca, Pompeii and White Victoria to show a gain of from 100 per cent. to 300 per cent. by this method of growing; Mr. Greiner's striking results were secured with the variety known as Prizetaker, grown from American seed. In the experiment at Southport, as well as one undertaken simultaneously at this Station, Wethersfield Red was used, the object being to make the test with a variety very largely grown in this State. When the onions were harvested the total weight and bulk of the crop from seed and of that from transplanted seedlings was ascertained; fifty bulbs selected at random from each were then measured to find the average circumference, and finally ten of the largest bulbs in each lot were selected for photographing. Plate I, Fig. 1, shows the comparative size of the bulbs. One-half of the seeded rows at the Station were thinned out when the plants were about eight inches high, so that the remaining plants were about three inches apart, thus corresponding to the transplanted seedlings. The smaller size of the bulbs grown at the Station was due to the fact that the soil was not well suited to onions.

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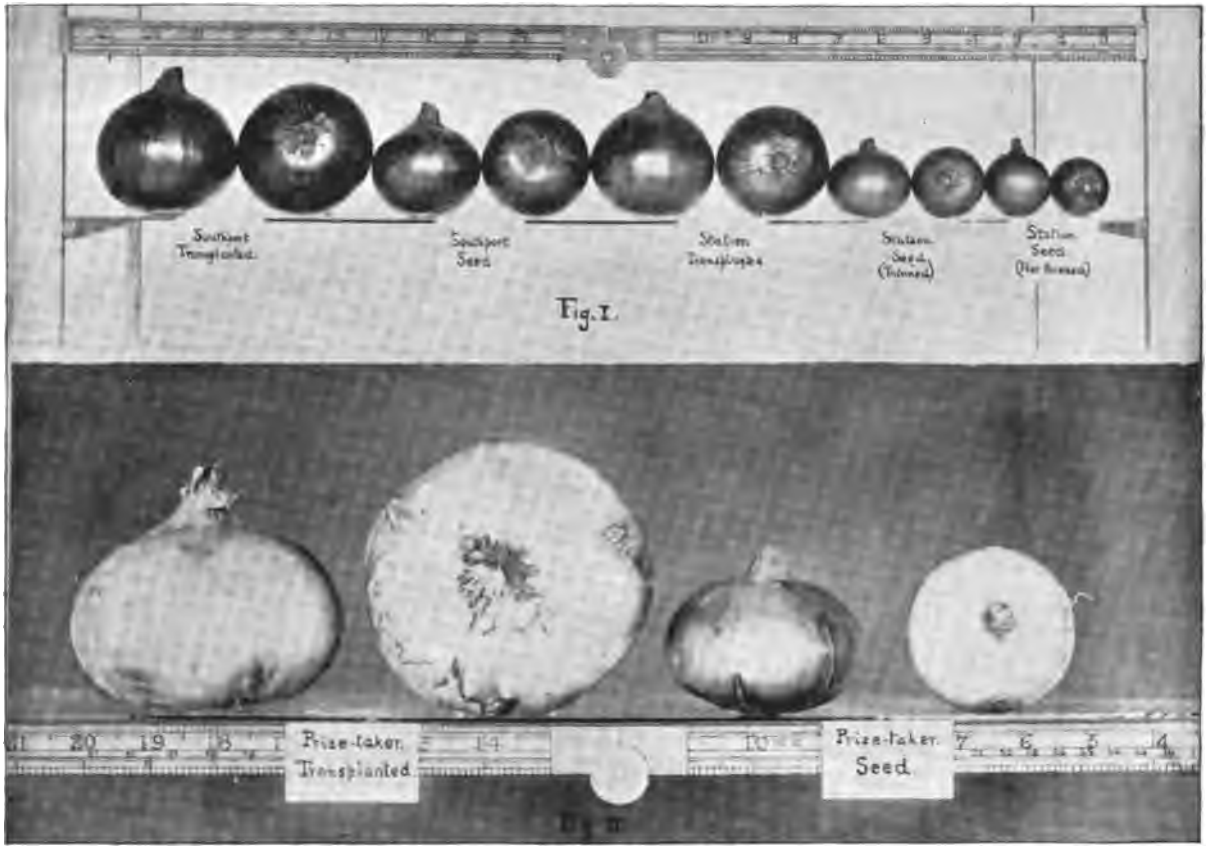

PLATE I. COMPARATIVE TESTS WITH ONIONS.

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Table III, p. 179, gives the results as regards the yield and the quality of the crop. It will be seen that in the Southport experiment there was a gain in favor of the transplanted onions of 81 per cent. in weight, and of 65 per cent. in the average size of the bulbs. The advantage of transplanting to avoid smut has already been commented on.

The results obtained at the Station exhibit still greater contrasts; in fact the crop obtained from seed was fit for nothing but pickling, whereas the transplanted seedlings gave a full yield of fair-sized bulbs. When the plants from seed were about three inches high they were attacked by cut-worms. It was impossible to determine accurately the damage from this cause, but a moderate estimate would place the loss at 25 per cent.; these were counted as "missing." On the transplanted rows the onions were almost a month in advance of the others and practically escaped injury. The advantage gained by thinning out the seed-rows was only what might have been expected.

After the completion of these experiments it was learned that Mr. L. C. Beecher, of Woodbridge, had tried the same method, and through Mr. Beecher's kindness I am enabled to publish his results. These are of the greater interest in that the seed used was of the variety Prizetaker, so highly recommended for transplanting.

The seed was sown in flats about March 20th and transplanted on May 14th. Two drills were made, each 25 feet long; the fertilizer was sown in them, and as the soil and weather were very dry the soil in the drills was thoroughly watered. The seedlings were then dropped three inches apart in the drills and the earth from both sides was drawn up firmly to them. Meanwhile seed from the same package had been sown in ten rows, each 10 feet long, immediately adjoining but at right angles to the transplanted rows. At the time of transplanting, the plants from seed were two inches high. Both lots received the same care and treatment throughout the season except for the less weeding required by the transplanted rows. The fifty feet of transplanted onions yielded two bushels and one peck of bulbs, while the 100 feet of onions from seed yielded only two bushels, a gain in favor of the former of over 100 per cent. The individual bulbs also showed a marked difference in size, the smallest of the transplanted bulbs being larger than the largest bulb from seed. Two of the largest of each kind were brought to the

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Station by Mr. Beecher and photographed (Plate I, Fig. 2). These measured respectively 13 inches and 8.7 inches in circumference. Mr. Beecher further states that the transplanted bulbs matured from two to three weeks earlier than those from seed, and that there were much fewer scallions among the former than among the latter. These very large onions would seem to be rather too large for the ordinary onion trade, but, as noted by several growers, they could doubtless be brought to compare favorably in size and appearance with the imported Spanish onions which bring fancy prices.

Summary.

The experiments above described show the following advantages of starting onion-seed in flats with heat, and transplanting the seedlings to the field.

1. This method insures a clean crop even upon smutty land.
2. Transplanted onions are less liable to the attacks of cut-worms than onions sown in the field.
3. The crop matures earlier by three or four weeks.
4. The crop is larger by an average of 50 per cent. or more with native varieties, and the average increase with large foreign varieties may exceed 100 per cent.
5. The individual bulbs are larger and mature more evenly.
6. The increase in the size and quality of the crop, the earlier ripening, and the lessened expense incident to the care of the plants after transplanting, offset in a measure the cost and labor of raising and transplanting the seedlings.
7. This method may be applied with certain profit wherever it has been the custom to grow onions from sets upon smutty land, or in small quantities for home use or small sales.
8. Several observers state that this method is applicable on a large commercial scale. Carefully estimated figures relative to the number of seedlings required per acre, the quantity and cost of sash for forcing-frames, the labor and time required for transplanting, the comparative cost of caring for the crop, and the comparative value of the yield, will be found in "The New Onion Culture," by T. Greiner, LaSalle, N. Y., 2d edition, revised, Jan., 1892; Bull. Ohio Agr. Exp. Station, 2d Series, Vol. III, No. 9; Bull. Tenn. Agr. Exp. Station, Vol. V, No. 4; and Bull. N. Dak. Agr. Exp. Station, No. 12.

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A LEAF CURL OF PLUM.

By Wm. C. Sturgis.

On June 6th of the past summer I received from Mr. J. L. Raub, of New London, some leaves of a cultivated variety of Japan Plum which were evidently suffering from the attacks of a fungus related to that which causes the "leaf-curl" of peach. In this case the appearance was very peculiar. The fungus had attacked the terminal shoots and young leaves, causing them to become swollen and distorted. The young green shoots were in some cases swollen to three or four times their natural size, and transformed into a semi-hollow mass of spongy tissue, externally mealy in appearance, and white or pinkish in color. Sometimes the whole cluster of young leaves at the tip of a diseased shoot was involved, so that the individual leaves were hardly distinguishable; in other cases the stalks and bases only of the leaves were attacked and the narrow green leaf-blade presented the peculiar appearance of growing from the white spongy mass below. At this time the few fruits which had set were about a quarter of an inch long. The fruit itself, that is the ovary of the flower, was not invaded by the fungus to any extent; the structure was normal and the young stone could easily be seen when the fruit was cut open; it was certainly not, therefore, a case of "plum-pockets." The stems of the fruit were, however, diseased in almost every case; they were very much swollen, whitish and mealy in appearance, and bore at their extremities the dried petals and stamens together with the young fruit. Specimens of the diseased tips are figured in Pl. II. Investigation of Mr. Raub's orchard showed that fully 80 per cent. of the plum trees were suffering from the disease, almost every terminal shoot of the season's growth being affected. The perennial character of the disease was indicated by the fact that although when it appeared the previous season, the diseased leaves and twigs had been removed and burned as fast as they formed, this proceeding proved of no avail in checking the trouble, and it reappeared the following spring with such virulence that much more radical measures became necessary. Under the circumstances, the only course to be recommended consisted in removing and burning the infested twigs as far as practicable and in pruning severely in the early winter, cutting out and destroying most

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of the present season's growth. If this were followed by treatment of the trees in early spring with a strong solution of copper sulphate, and later with Bordeaux mixture, it seemed probable that the disease might be eradicated, and Mr. Raub was so advised.

The accurate determination of the fungus causing the trouble proved to be a matter of some difficulty. Several species of the genus to which this fungus belongs, are known to attack the leaves and young shoots of our wild and cultivated plums; these species are enumerated as follows by Atkinson :*

On *Prunus Americana*, Marsh. (Wild Red Plum) *Exoascus decipiens*, Atk.

On *Prunus nigra*, Ait. (Wild Red Plum) *Exoascus decipiens*, Atk.

On *Prunus angustifolia*, Marsh. (Chickasaw Plum) *Exoascus mirabilis*, Atk.

On *Prunus hortulana*, Bailey. (Wild Goose Plum) *Exoascus mirabilis*, Atk.

On *Prunus triflora*, Roxb. (Japan Plum) *Exoascus rhizipes*, Atk.

E. F. Smith† records the occurrence of a leaf-curl on cultivated varieties of *Prunus Chicasa* (*Prunus angustifolia*) in Maryland and Georgia, which Atkinson (l. c., p. 336) refers to *Exoascus mirabilis*. Finally, Crozier reports a plum leaf-curl "on a vigorous grower and light bearer known as Maquaketa," at Ames, Iowa. This fungus Atkinson again (l. c., p. 340) identifies with some doubt as *Exoascus mirabilis*. It will thus be seen that all the varieties of our cultivated plums of the *Americana*, *Chicasa*, and *hortulana* types, as well as the Japanese varieties, are subject to leaf-curl caused by one of three species of a fungus belonging to the genus *Exoascus*. Microscopic examination of the species in question leaves little room for doubt that it is identical with Atkinson's *Exoascus mirabilis*. This species would seem to be wide-spread, and very destructive in its effects. Atkinson reports it from Columbia, S. C., and Auburn, Ala., on the wild Chickasaw plum and its cultivated varieties; on the same host in Iowa; and on the cultivated varieties of the Wild Goose plum (*P. hortulana*) from four localities in Iowa. Smith and Atkinson record its occurrence in Maryland and Georgia. Galloway and

*Cornell Univ. Ag. Exp. Station, Bull. 73, Sept., 1894.

†Journal of Mycology, Vol. VI., p. 108, 1891.

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PLATE II. LEAF-CURL OF JAPAN PLUM.

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Atkinson report it on the variety Maquaketa at Ames, Iowa, this variety, according to Atkinson, being "inadvertently referred to the Chickasaw plum." Finally, its occurrence in Connecticut marks an extreme easterly limit.

The serious injury which it causes has been already referred to, as well as the means which may be taken to eradicate it. It must be borne in mind that this fungus belongs to a genus in which the vegetative portion or *mycelium* lives from year to year within the tissues of the diseased shoots; the pruning-knife must therefore be depended upon to remove the existing trouble, and fungicides to prevent subsequent infection. One of the striking characteristics of the Japanese plums heretofore, has been their comparative freedom from the diseases to which our native varieties are subject. The appearance of so serious a trouble as this leaf-curl is therefore of great scientific and economic importance, and growers are warned to watch for the first appearance of the disease, and to take immediate action to prevent its spread.

MISCELLANEOUS NOTES ON VARIOUS FUNGUS DISEASES.

By Wm. C. Sturgis.

The Powdery Mildew of Grapes (*Uncinula spiralis, B. & C.*).—Early in August a package of grapes was received from Mr. A. B. Plant of Branford, who reported that a large percentage of his grapes had been ruined by a disease quite unfamiliar to him, but well illustrated by the specimens sent for examination. The appearance of the grapes was peculiar, and inasmuch as this particular effect of fungous attack is somewhat exceptional, a brief note on the subject may be of interest.

The surface of the grapes showed a somewhat blotchy appearance, and the skin was abnormally thick and leathery; the principal damage however, was due to a cracking of the berries lengthwise, in some cases so severe as to expose the seeds. Microscopic examination of the berries showed no trace of any fungus, but the peculiar thickening of the skin in places, led to the conclusion that the cracking was due primarily to an early attack on the part of the fungus mentioned above. The powdery mildew is much less common in Connecticut, and does less damage as a rule than the downy mildew [*Plas-*

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mopara viticola (B. & C.)]. When the former does occur it is usually confined to the upper surface of the leaves, and seldom attacks the fruit. In this case however, the leaves were very slightly affected. The powdery mildew is superficial in its manner of growth, sending its vegetative and fruiting threads in the form of a white, frost-like covering over the surface of the host and drawing nourishment from the latter by means of small suckers which penetrate the tissue. If, as in this case, the grapes are attacked while very small, those portions of the surface upon which the fungus grows, cease enlarging because of the exhausting effect of the fungus; the tissues beneath, being uninjured, continue growing, and eventually the difference in increase between the internal portions and the external cells causes the skin to split open. As the grapes increase in size, the same conditions being operative, the crack becomes deeper, and the smaller the grapes when first attacked, the deeper will the crack eventually extend. Meanwhile spraying begun after the fungus has injured portions of the surface of the fruit beyond recovery, checks its further spread upon the fruit or to the leaves, rains wash off the now dead and loosely adhering fungus threads, the suckers dry up or are concealed in the tissues of the thickened skin, and no evidences of the attack remain except the cracks, which are deepened continually by the natural growth of the berry. Such seems to have been the cause of the trouble in the present instance. The remedy consists in early and thorough spraying, once just before the blossoms open, and again as soon as the blossoms have fallen.

A Disease of Melons (*Alternaria sp.*).—Late in August specimens of Musk-melon leaves were received at the Station from Mr. S. B. Wakeman of Saugatuck. The leaves were evidently diseased, and Mr. Wakeman wrote that the trouble was spreading very rapidly over his melon ground notwithstanding applications of Bordeaux mixture. A visit to Saugatuck confirmed Mr. Wakeman's report. Of three large fields of melons, one was completely ruined, and the other two showed abundant evidences of disease. The trouble seemed to start at the center of the hills and extend rapidly outwards. It was characterized by a wilting of the leaves, followed by the appearance of small yellowish spots and blotches; these increased rapidly in size, the surface of the diseased areas became marked with dark, concentric rings, the tissues became dry and brittle, and upon all the older spots there was a copious growth of black mould distinctly visible with a

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lens. Microscopic examination showed that the leaf-tissue in every diseased spot was traversed by delicate, colorless threads, which, coming to the surface either singly or in little erect tufts, gave rise to short chains of large, brown, club-shaped spores, provided with a long erect appendage, and serving to place the fungus in the genus *Alternaria*. No other fungus was found in connection with the trouble, and this, together with the fact that the *Alternaria* was found abundantly in every one of the diseased leaves examined, produced a strong impression that the disease was due to the fungus in question. There was no opportunity however, to prove this supposition by the inoculation of sound leaves with a pure culture of the *Alternaria*. When the field was first examined, late in August, the plants had received two applications of Bordeaux mixture, but it had not been applied very evenly. The only thing to be done under the circumstances was to recommend another immediate and thorough application of Bordeaux mixture, especially upon those portions of the vines at a distance from the centre, which as yet showed no symptoms of the disease. There was but little hope however, of saving the crop to any great extent, and as the result proved, the disease continued to spread even after thorough treatment of the vines with Bordeaux mixture.

There are a number of fungi which are known to affect the leaves of melons, but the one in question is probably identical with the species of *Alternaria* recently described by Smith and by Peglion as affecting melon-leaves in this country and in Italy. Whether in this case the fungus was a true parasite, or whether it merely followed an injury due to other causes, must remain an open question for the present.*

*Since the above was written, pure cultures of this fungus have been obtained by inoculating sterilized tubes of prune-agar with spores from the diseased leaves. These cultures furnished spores which were used in the inoculation of leaves of growing melon and tomato plants. In the case of the melon the inoculation has been successful even upon normal, uninjured leaf-tissue, proving beyond question the connection between the fungus and the disease. With the tomato, the inoculation of leaf-tissues which were injured has resulted in a diseased condition identical with that seen in the melon, and at the present time similar results seem liable to follow from the inoculation of sound tissues. Should these experiments prove that the tomato as well as the melon is susceptible to this disease, some doubt may arise as to the propriety of the name which has been given to the fungus. In other words the fungus causing a diseased condition of melon-leaves may prove to be identical with a species previously described from some other plant. It is hoped that the series of cultures and inoculations now in progress at this Station may serve to settle this question.

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THE LEAF-SPOT OF PLUMS (*Cylindrosporium Padi*, Karst.).—This fungus, which attacks both the plum and cherry, is not usually abundant in Connecticut, but this year there was at least one serious case. The trouble is manifested by the premature yellowing and falling of the leaves. The affected leaves are marked upon the upper surface with numerous small greenish or brownish spots with paler centres and sharply defined borders. Later the tissue of these diseased spots dies and separates from the surrounding tissue, leaving the leaf pierced with a number of roundish holes whence the name "*shot-hole fungus*," sometimes applied to the disease. The owner of the orchard in which the trouble appeared wrote under date of Aug. 17th, "Three-fourths of the leaves are off now or soon will be; the trees have not been sprayed. My trees at home, of the same variety, which have been sprayed twice, are the picture of health." Comment is unnecessary.

HOLLYHOCK RUST (*Puccinia Malvacearum*, Mont.).—This fungus is interesting as having sprung into notoriety within comparatively few years. It was first described from Chili, and spread thence to Europe, where it increased so rapidly that by the year 1875 it had become a well-known disease of great severity. It first appeared in this country in 1886, and has spread with remarkable rapidity, particularly in the Eastern States, so much so that it now ranks as a fairly common disease of hollyhocks, and it is by no means rare to find all the plants in a single locality completely ruined by it. Fortunately it is quite unmistakable and easily recognized. It is characterized by the appearance, on the lower surface of the leaves, of small warts about twice the size of a pin-head; these are at first yellow, but soon change to a purplish-gray or brown color. On breaking open one of these little warts, the interior is found to be composed entirely of a dark brown dust—the two-celled spores of the fungus. The fungus appears to pass the winter in the remains of old hollyhock plants, or upon the first-year leaves, whence it spreads in the spring to the new growth, appearing visibly upon the leaves and stems in June. In severe cases the leaves are so permeated by the fungus that they wither and fall early, and the flowers fail to mature.

The "rusts" are all extremely difficult to combat with fungicides. Their appearance upon the surface only after a long period spent within the tissues of the host, protects them from injury until most of the damage has been done; while their large,

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thick-walled spores seem to be peculiarly resistant to the effects of fungicides. The most practical method of preventing the spread of the disease would seem to be the destruction by fire of all refuse of infested plants, and the avoidance of land upon which rusted hollyhocks have previously grown. Picking off and burning the leaves as fast as the disease appears upon them would doubtless assist in checking its spread; and in England a wash consisting of two tablespoonfulls *of a saturated solution* of permanganate of potash, added to one quart of water, and applied with a sponge, has proved efficacious in checking the disease.

NOTES ON INJURIES DUE TO PHYSIOLOGICAL CAUSES.

By Wm. C. Sturgis.

Winter Killing of Peach Trees.

A peculiar and rather obscure trouble manifested itself last spring in a number of peach orchards throughout the State, and specimens were sent to the Station for examination. In every case the symptoms were as follows: With the opening of the season the trees were apparently thrifty, and produced leaves and blossoms normally. About the middle of May evidences of a diseased condition suddenly appeared. One portion of an otherwise thrifty tree seemed on the point of dying; upon cutting through the bark, the wood appeared blackened and dead, or in less severe cases showed brownish streaks, especially in the delicate tissue just beneath the bark. The leaves upon these affected portions ceased growing and became stunted and wilted, while a red discoloration appeared in spots upon the leaves, especially at the tips. No external cause of the trouble could be found; borers were in no case present, nor could any parasitic fungus be traced in or upon the affected portions. No serious frost had occurred since the trees began their growth. Eventually the trees which seemed to be but slightly affected recovered; while others in which the injury was more severe, suffered a gradual loss of vitality, and finally died. I was for some time at a loss to determine the cause of the injury, but conversation with a number of experienced growers led to the conclusion that it was due to severe and sudden changes of temperature during the winter. It will be remembered that the winter of '94–'95 was characterized by two or three short periods of extremely cold weather

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accompanied by high winds, preceded and followed by longer periods of mild weather. It seems highly probable that these sudden changes of temperature affected unfavorably a few trees here or there which were constitutionally weak, and whose thin bark caused the delicate underlying tissues to be peculiarly susceptible to such changes. Under such circumstances the tissues which remained uninjured might perform their functions for a time, and enable the tree to leaf out, while in some cases the trees might be injured past recovery. There seems to be no practical method of guarding against injury of this kind, and the conditions which induce it are probably too exceptional to warrant serious apprehension.

Frost Injury to Pears.

A peculiar injury to pears was very prevalent during the spring of 1895 in many sections of the State. It appeared very early upon the fruit, when the latter was from one-half to three-quarters of an inch long, as a russet band or blotch upon the surface. Generally this russet appearance was limited to the calyx end of the fruit; occasionally it partly or entirely encircled the fruit midway between the stem and the calyx. The same appearance was seen rarely upon apples. The opening of the season was characterized by one or two sharp frosts after fruit had set, and it was natural to regard the late frosts and the injury as cause and effect. This view is substantiated by Mr. G. Harold Powell of Cornell University, who says*: "This belt is due to an injury to the epidermis of the fruit in its young stage, and is caused by the freezing of dew collected on these spaces. The fruit at this time is upright, and the place where the dew collects is probably determined by the formation and position of the fruit." The russet appearance is a result of the natural process by which plants commonly repair their surface injuries, viz., the development of cork. The portions of the epidermis thus injured and healed, cease expanding, and as the remainder of the fruit continues its growth, the uninjured epidermal cells immediately adjoining the injured portion become gradually ruptured, and in their turn give rise to a growth of cork, so that the russet area increases in extent with the growth of the fruit.

* Garden and Forest, Vol. VIII., p. 417, Oct. 16th, 1895.

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NOTES ON INJURIOUS INSECTS.

By Wm. C. Sturgis.

The Wheat Midge (*Cecidomyia Tritici.*).—A number of heads of rye were received early in June from Coventry which were undoubtedly suffering from the depredations of this insect. The heads were partially eaten out, the lower kernels being entirely destroyed, leaving only the chaff. Our correspondent stated that at the time of writing, June 5th, the trouble was spreading rapidly. The injury is caused by the grubs or maggots of a small insect nearly related to the "Hessian Fly" (*Cecidomyia destructor*). The eggs are deposited among the chaff of the heads of a variety of grains, and the small grubs, which soon hatch out, eat into and destroy the maturing kernels. The only remedies which have been recommended for this pest consist in gathering and burning the infested heads; deep plowing of infested fields, whereby many of the insects are killed; planting a small quantity of grain very early, in order that after it has become infested by the midge it may be ploughed under or destroyed before the land is sown for the final crop; and planting varieties which mature early, such varieties being less liable to attack than those ripening later.

The Bark-beetle (*Scolytus rugulosus*, Ratz.).—This insect, to which attention was called in our Report for 1894, seems to be increasing in the peach orchards of the State, and bids fair to become a serious pest. Specimens of the bark and wood of peach trees received in May from the eastern part of the State were completely riddled with the small "shot-hole" punctures of the insect, each puncture exuding a drop of gum. The only remedy which can be suggested is of a purely preventive nature, and consists in applying to trees liable to attack, a lime-wash to which a small quantity of Paris green has been added. In case a tree is very badly infested with this borer, it had better be destroyed at once; trees only slightly attacked have been known to recover.

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Scale-Insects.*

The San José Scale (*Aspidiotus perniciosus*, Comst.).—This pest was found last summer for the first time in Connecticut, infesting an orchard of peach, plum, and apple trees, in the vicinity of New London. The discovery was deemed of sufficient importance to be made the subject of a bulletin (Bull. 121, July 1895, republished in this Report, p. 194), which was distributed widely, and the reader is referred to that publication for detailed information regarding the occurrence, characteristics, and life-history of the insect, and the methods which have elsewhere proved successful in eradicating it. Since the publication of our Bulletin 121, information has been received of the appearance of the scale in other orchards near New London, and specimens have also been received from Hartford. There can be little doubt that the scale was introduced into Connecticut upon stock purchased from a New Jersey nursery prior to 1894, at which time the proprietors of the nursery discovered that their stock was infested, and by prompt and energetic measures succeeded in stamping out the trouble. Meanwhile however, between the years 1890 and 1894, during which time the infested stock had escaped notice, the firm had supplied no less than ninety-two individuals in this State with young fruit-trees. It seemed probable, therefore, that the San José Scale might be much more widely distributed in Connecticut than the information at hand would lead one to suppose.

Great credit is due to the New Jersey firm of nurserymen for the prompt and thorough manner in which they met and overcame the trouble in their own nurseries, as soon as the matter was called to their attention; and also for their courtesy in responding to our request for a list of the fruit-growers in Connecticut whom they had supplied with stock between the years 1890 and 1895. A circular letter was recently sent to each person on this list requesting him to examine such stock as he had purchased in New Jersey between the years above mentioned, and to report to us whether or not the San José scale was to be found upon it. A postal card was enclosed with each circular, together with a copy of our Bulletin 121. The replies thus far received show cause for some apprehension; the only locality where a serious outbreak is definitely known to have occurred is in the neighbor-

* For the identification of most of the species herein noted I am indebted to the kindness of Profs. Comstock and Slingerland of Cornell University.

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hood of New London, and there vigorous treatment of the infected trees is proving effectual. In Hartford the scale was found upon one pear tree purchased in New Jersey, but it had not spread to other trees, and the infested tree was, upon our recommendation, destroyed. The latest information received is from the neighborhood of Bridgeport, where, judging from samples lately received, the scale is present in numbers sufficient to cause very great damage to apple, pear, and peach stock. The owner of the trees in question has expressed his determination either to destroy the infested trees or to rid them of the pest by treatment with whale-oil soap.

SCALE ON TULIP-TREES (*Lecanium Tiliæ*, Fitch). — Specimens of this large, convex, brown scale were received in August from Hartford, where they were reported as covering the bark of tulip-trees (*Liriodendron tulipifera*), and injuring the trees to a very serious extent. It has also occurred upon tulip-trees in New Haven. According to Prof. Slingerland this insect is identical with that described by Prof. Cook* as *Lecanium tulipiferæ*. The owner of the infested trees was advised to scrape off as many of the scales as could be conveniently reached, to apply strong kerosene emulsion in the late autumn as recommended for the San José scale in our Bull. 121, and to follow this up with an application of a weaker form of the emulsion as soon as the young insects were seen to be emerging from beneath the scales, which would probably take place during the following June. We have yet to hear the result of this treatment, but there is every reason to suppose that it will prove satisfactory.

SCALE ON OAK (*Asterodiaspis quercicola*, Bouché).†—Specimens of this insect were received early last March from the proprietors of the Elm City Nursery of New Haven; they occurred in large numbers on the limbs and terminal twigs of the British or Black Oak, *Quercus Robur*, and were undoubtedly the cause of considerable injury. The insect however, is not a common one, and its appearance in numbers sufficient to cause serious apprehension is hardly to be expected.

The scales received early in March covered living eggs, which, in the warmth of the laboratory hatched out during the last week in April, probably at least two weeks earlier than they

* Canadian Entomologist, Vol. X, p. 192.

† U. S. Dept. of Agric., Report for 1880, p. 330.

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would have hatched in the open air. Two or three applications of kerosene emulsion or whale-oil soap, beginning about the middle or latter part of May, would doubtless be an effective remedy. In very severe cases a treatment with strong kerosene emulsion in winter, or as soon as the trees become thoroughly dormant, might be advisable. This treatment is recommended only for nursery stock; if large trees are infested they had better be destroyed.

SCALE ON HONEYSUCKLE (*Lecanium sp.*).—Our cultivated shrubs are not as a rule subject to injury from scale insects; it is therefore of interest to note the occurrence of a species of *Lecanium* on a shrubby honeysuckle, probably one of the Japanese species of the genus *Diervilla*, commonly cultivated under the name *Weigela*. Specimens of this shrub were received from Waterbury in June, but they were too scanty to allow of accurate determination. The scales were numerous upon all of the twigs received, and are evidently capable of doing serious injury to this most useful and showy shrub. In this case again, applications in early summer of kerosene emulsion or whale-oil soap are to be recommended.

THE SAN JOSÉ SCALE.*

BY WM. C. STURGIS AND W. E. BRITTON.

Occurrence in Connecticut.—The appearance of the San José scale (*Aspidiotus perniciosus*) is an event of very great importance to all our fruit growers.

During a visit to the orchard of Mr. Joseph L. Raub of New London, on June 12th, we were struck by the appearance of certain young peach trees which were then apparently dead, though earlier in the season they had put out a few leaves near the tips, and last year had been exceptionally vigorous. Close inspection showed that in every case the trunk and larger limbs were fairly incrusted with a grayish coating composed of vast numbers of scale insects. These so resembled the published drawings of the

* This paper, first printed in Bulletin 121 of this Station, is here reproduced in slightly amended form. See also "Notes on Injurious Insects," page 192.

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San José scale, Fig. 1, page 196, that they were suspected to be that pest. Specimens were at once submitted to the experienced entomologists, Messrs. L. O. Howard of the U. S. Department of Agriculture and M. V. Slingerland of Cornell University, who kindly examined them and confirmed our conclusion. The specimens secured on June 12th were small and undeveloped, having apparently died while still in the hibernating condition. On June 20th, careful notes were taken of the condition and surroundings of the orchard, which occupies an isolated position on the outskirts of the city, with no other orchard in its vicinity, and which contains a variety of fruit trees from one to four years of age. It was evident that the scale had not come from the neighborhood, but it was still more evident that the orchard in its present condition might be a fertile source of infection, for living scales were found upon fully one-half of the trees. All the trees came originally from a firm in New Jersey, and were set out in or since 1891. The plantings of 1891 and 1892 were very badly affected, many of the trees being completely dead and covered with the scale, others being killed to the ground but sending up new shoots from the roots. Living scales were found principally upon the trees set out in 1893, but the insect had not yet completely infested these trees, which remained comparatively vigorous. The trees set out in 1894 were practically free from scale. From these facts it is evident that the insect was introduced upon the stock of 1891 and 1892 and had developed until the trees died; and that the stock of 1893, while originally infested equally with the previous plantings, had remained sufficiently vigorous to show but little evidence of the attack. Doubtless, however, these trees offered suitable conditions for the breeding of the pest and its spread to the still unaffected trees of the planting of 1894. The freedom from scale of the latter was undoubtedly due to the energetic and successful measures adopted in 1894 by the New Jersey firm to eradicate the scale from their nurseries by the destruction of all infested trees, and the fumigation of all suspected stock before placing it upon the market.

Since our first visit, Mr. Raub has undertaken to destroy the trees in his orchard which are most seriously infested, and to apply to the others a strong solution of whale-oil soap. This will undoubtedly check the spread of the scale until next winter, when more drastic remedies can be applied to the dormant trees.

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General appearance of the Scale.—When the scales occur singly they are not easy to detect with the naked eye; but when, as is usually the case, they occur in groups, they are easily seen as a grayish and roughened or pimply coating upon the bark, as shown in Fig. 1. This coating, when scraped off with the

FIG. 1.—San José Scale: Apple Branch, with scales—natural size.—(From *Insect Life.*)

thumb-nail or with the blade of a knife, appears mingled with a yellowish liquid if the insects composing it are alive. In severe cases the bark is completely covered with this scaly coating, and upon removing the bark the delicate tissues beneath are seen to present a pinkish or purplish color. When a tree is but slightly affected, the scales are usually found singly or in small groups upon the twigs, often at the base of the leaves. When the scales occur upon the fruit, it is usually in the form of scattered individuals closely attached to the surface, each one being surrounded with a purplish ring, Fig. 2. The separate scales measure, when fully grown, about one-eighth of an inch in diameter, are almost circular, slightly convex with a minute blackish projection in the center, and are of a dirty brown or gray color. The scale may be easily lifted upon the point of a pen-knife, and the insect beneath it, if alive, is seen as a small bit of yellowish jelly. This scale differs in appearance from other scales commonly found upon fruit trees; it is rounder than the "oyster-shell bark louse," and is smaller and darker in

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color than the "scurfy bark louse." In fact it is the only scale among those commonly found on fruit trees in Connecticut, which is distinctly circular in outline.

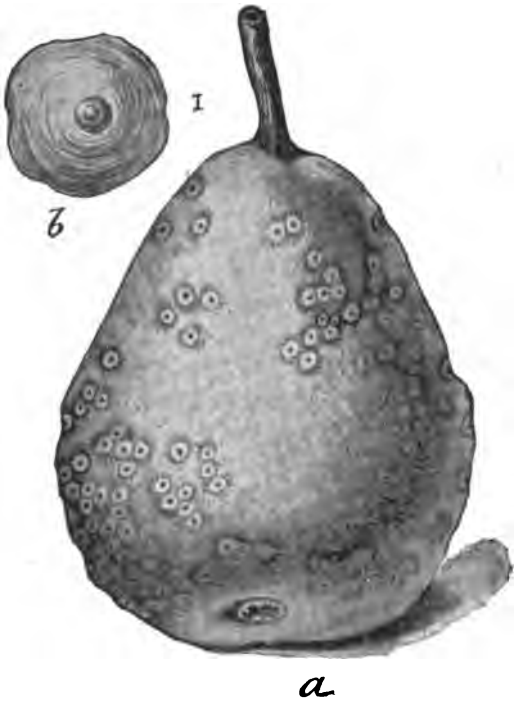

FIG. 2.—San José Scale: *a*, Pear, moderately infested—natural size: *b*, female scale—enlarged.—(From *Insect Life.*)

Effect of the scale on the trees.—The pernicious effects of the San José scale are in a great measure due to its inconspicuous character, and to the fact that its effect upon the vitality of the tree is not at once apparent. During the first season of its attack, the tree may be apparently healthy, with full leafage and abundant fruit. As the scale spreads, however, the effect becomes more plainly visible, though it is such as might readily be attributed to the attacks of borers or to drought. Only the most careful observation will discover the true cause of disturbance. Generally by the second or third season only does the scale become so abundant as to be conspicuous, and by that time the whole tree is infested with the grayish coating of scales; in its weakened

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condition it succumbs easily to an exceptionally severe winter, and though it may put forth leaves, they shortly wither, and before the cause of the trouble is actually known, the tree is practically dead. If taken in time, however, it is not difficult to check its ravages, and we would therefore urge all fruit-growers to inspect their trees with care, and to send us specimens of any insect found bearing resemblance to this scale.

Plants subject to the attacks of the scale.—The San José scale has been thus far found in Connecticut upon the Peach, Apple, Pear, Plum and Currant, but information from other States shows that it may attack most of our large and small fruits, and the rose, hawthorn, elm, basswood, alder, sumach, English walnut and various evergreens.

Origin and spread.—This insect was formerly supposed to have been introduced into California from Chili, in the year 1870, but later information obtained by Mr. L. O. Howard, Chief of the Division of Entomology, U. S. Department of Agriculture, seems to show that our Pacific coast was probably its original home, whence it spread to Chili and other countries.

It was first noticed by fruit shippers near San José, Santa Clara County, California. No exterminative measures were at once taken and a few years later the Pacific slope was largely infested.

Prof. J. H. Comstock first described it in the report of the U. S. Department of Agriculture for 1880. He found it doing much damage in California and regarded it as the most destructive scale insect known.

The Atlantic States, however, were supposed to be uninfested until the summer of 1893, when it appeared upon orchard trees in Charlottesville, Va. The attention of Dr. C. V. Riley, then U. S. Entomologist, was called to the fact of its presence, and measures for its suppression were immediately employed.

It was soon discovered that this was not the only center of infection, but that the scale existed at De Funiak Spring, Florida; Bartle, Indiana; Neavitt and Chestertown, Maryland; Lewisburg and Atglen, Pennsylvania, and in several localities in New York and New Jersey. It has recently been found in Delaware and on Long Island.

The introduction of the San José scale into the Eastern States has been traced to the importation of Japanese plum trees into New Jersey from California.

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Like other scale insects, the San José scale can spread only a short distance each year, unless its distribution is aided by the agency of wind, water or animals.

Probably its distribution in this country has been largely effected through shipments of fruit and nursery stock; but the insect has been found upon other insects, and these, especially the flying ones, have doubtless assisted in its dissemination.

Life History.—This insect is viviparous; i. e., brings forth living young, Fig. 3.

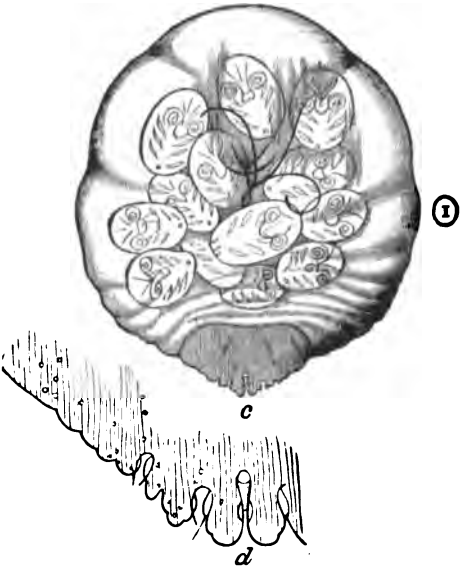

FIG. 3.—San José Scale insect: *c*, adult female containing young—greatly enlarged: *d*, anal fringe of same—still more enlarged.—(From *Insect Life.*)

In California three annual broods appear, but for our climate the number of yearly broods has not been definitely determined.

The San José scale survives the winter either in the egg or in a half grown state. It becomes fully developed and reproduces about the last of May or first of June, and successive broods appear until winter begins.

The newly born or hatched individuals, Fig. 4, unlike their female parent, have no scaly covering but crawl about like ordinary plant lice. They are very small at first. The period of activity lasts but a day or two, sometimes only a few hours, when the young insects settle upon the bark and become fixed.

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The scaly covering then begins to form. The insect soon molts and the cast-off skin uniting with a waxy secretion forms the visible external scale.

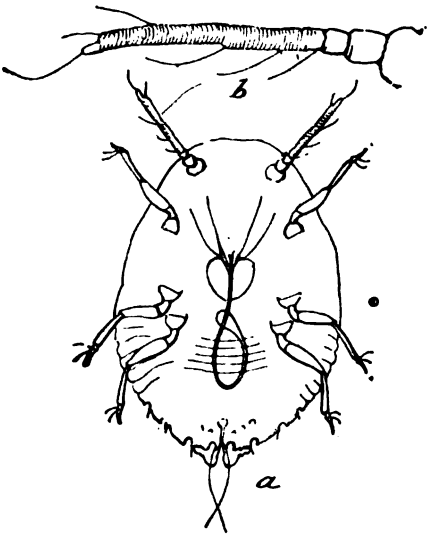

FIG. 4.—San José Scale insect: *a*, young larva—greatly enlarged: *b*, antenna of same—still more enlarged.—(From *Insect Life*.)

The female insect cannot change her place after the scaly covering begins to form, but the male is able to emerge from his cover, and being winged can travel short distances, Fig. 5.

Remedies.—As soon as the scale is discovered, and before any wash or other treatment is applied, the trees should be cut back as severely as seems advisable, and all the cuttings burned, as, in the case of newly infected stock, most of the scales occur on the terminal shoots.

Gas Treatment.—This requires an oiled canvas or some other gas-tight tent in which the tree is enveloped. Hydrocyanic acid gas is then generated by pouring, say three fluid ounces of water into an earthen-ware vessel, adding one fluid ounce of commercial sulphuric acid (oil of vitriol), and lastly one ounce (by weight) of fused potassium cyanide, these materials making enough gas to fill a space of one hundred and fifty cubic feet.

If this treatment is employed, the greatest caution must be taken not to breathe the gas, for hydrocyanic (or prussic) acid is a most dangerous poison.

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According to Lintner (Bull. N. Y. State Mus., Vol. 3, No. 13, p. 302) Mr. Howard lately reports the gas treatment as not wholly efficacious in Virginia, possibly owing to the more complete dormancy of the insects in the East than in California, where it was first successfully employed.

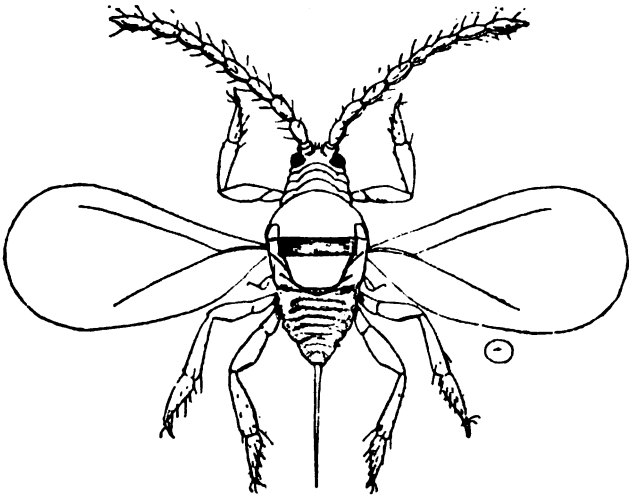

FIG. 5.—San José Scale insect: male adult—greatly enlarged.—(From *Insect Life.*)

Summer Treatment.—Either weak rosin wash or dilute kerosene emulsion is advised for keeping the scale in check during the Summer. Neither will do more than this, since the young hatch out at intervals throughout the Summer, and this treatment will not kill the mature scales.

The following formulas are recommended :—

WEAK ROSIN WASH.

Rosin	20 pounds
Caustic soda	5 pounds
Fish-oil	2¼ pints
Water to make	100 gallons

Pulverize the rosin and soda, add the oil, and place the mixture in a large kettle with water sufficient to cover it. Boil for one or two hours with occasional additions of water, until the compound will mix perfectly with water instead of breaking up into yellowish flakes. Dilute for use to 100 gallons.

STANDARD KEROSENE EMULSION.

Kerosene	2 gallons
Common soap or whale-oil soap	½ pound
Water	1 gallon

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Heat the solution of soap and add it boiling hot to the kerosene; churn the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens upon cooling, and should adhere without oiliness to the surface of glass. If the water is hard, add a little lye or soda, enough to make it feel very slightly slippery. For use, dilute with nine times its bulk of cold water.

Either of these washes should be applied at least three times during the Summer. As has been said, these washes will do no more than prevent the serious increase of the insects during the Summer. For thoroughly effective treatment we must rely upon strong washes applied in the Winter, when the trees are not liable to injury.

Winter Treatment.—The following applications are recommended for Winter use:

Whale-Oil Soap.—Two pounds of the soap are dissolved in one gallon of water and this solution is applied thoroughly, as a spray, or by means of a brush. Mr. Howard records this solution as "fatal to all the scales on the trees sprayed with it."

Strong Rosin Wash.—A rosin wash, made as given on page 201, but diluted to only 16 gallons, is recorded by Mr. Howard as "fatal to all the scales on the trees sprayed with it."

Potash Wash.—Dr. Smith recommends, as a result of his experiences in New Jersey, a wash consisting of a saturated solution of crude or commercial potash, i. e., potash in a quantity of water just sufficient to dissolve it. This is applied with a cloth or a brush, or as a spray. The potash serves to corrode and loosen the scales, killing many of the insects beneath them; and a spray of kerosene emulsion a month later completes the work of destruction.

On the whole, the Winter treatment with whale-oil soap, or strong rosin wash, seems to leave nothing to be desired, while in order to keep the insect in check during the Summer, or until this treatment can be safely applied, either of the two Summer washes described above will prove valuable.

Winter Treatment should be applied soon after the leaves fall, as the scales are thought to be more susceptible at that time than later in the winter.

Summer Treatment should be applied at least three times at intervals during the summer. Frequent rains necessitate repeated applications.

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FURTHER NOTES ON INJURIOUS INSECTS,

By W. E. Britton.

THE PLANT-HOUSE ALEYRODES.

(*Aleyrodes vaporariorum?* Westwood.)

Order, Hemiptera: Family, Aleyrodidæ.

For several months tomato plants in the forcing house have been infested with these small, scale-like insects. The larvæ are found upon the under surface of the lower leaves of the plants, appearing as small white specks. The adults, which much resemble tiny white moths, may be seen flying about.

The genus *Aleyrodes* has not been studied thoroughly in this country, and only a few of our species have been described. One species infesting the orange tree was figured and described by Riley and Howard, in Insect Life, vol. v, p. 219, having been named *A. citri*, previously, by Mr. Ashmead.

In the Report of the Kentucky Agricultural Experiment Station for 1890, p. 37, Prof. H. Garman records a species of *Aleyrodes* which occurs upon the strawberry in Kentucky. This insect answers very closely the description of *A. vaporariorum*, of Westwood.* It has been observed upon the leaves of *Abutilon avicennæ*.

Specimens from our forcing house were submitted to Prof. Garman, who reports that it is the same species which he found upon strawberry plants. I have also noticed this insect upon lettuce, cucumbers, *Ageratum Mexicanum*, *Maurandya Barclayana* and a species of *Abutilon*.

Prof. L. H. Bailey refers to this insect in N. Y. Cornell Station Bull. 28, p. 58, as being a pest of the tomato house. Dr. A. S. Packard mentions *A. vaporarium*† in his Guide to the Study of Insects, 9th ed., pp. 526 and 712, as occurring upon both strawberry and tomato plants.

The larvæ are covered along the edges and upon the dorsal surface with bristles, which can be seen with the naked eye. Many cast pupa skins are found fastened to the tomato leaves. The pupa skin cracks open along the back and allows the adult to escape. These pupa skins occur most abundantly on the older and lower leaves of the plant, while the young larvæ may

* Gardener's Chronicle, 1856, p. 852. † *A. vaporariorum* was probably intended.

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be found adhering closely to the younger and more tender leaves. (See plate III.)

Flitting about the tops of the plants are the small, white, moth-like adults which are mating and depositing eggs. The egg is oval, slightly conical, with the large end attached to the leaf. Two females were observed depositing eggs upon lettuce. The beak was inserted in the tissues of the leaf and an egg deposited. The female then turned, using her proboscis as a pivot, and continued to deposit eggs in a circle of about 1 m. diameter. In one instance this circle contained six, and in the other nine eggs. These eggs hatched in eleven days.

Eggs are not always deposited in circles: I have frequently found them single. When first deposited, the eggs have nearly the color of a lettuce leaf, but shortly become dark and brown.

In the adult stage both sexes have four wings, each with a single median vein. The color of the body is yellow, that of the wings, white. Antennæ are six-jointed.

Plate III shows the insect in the egg, larval and adult stages, from original drawings.

Tobacco fumes kill the adults, and in the greenhouse probably are the most satisfactory treatment. On plants out of doors, which cannot be fumigated easily, the insect may be held in check by frequent applications of whale-oil soap (1 lb. soap to 5 gallons water). Kerosene emulsion, which has proved most efficient against *A. citri*,* would doubtless destroy *A. vaporariorum* as well.

A LEAF MINER OF THE CAULIFLOWER.

(*Drosophila flaveola*, Meigen.)

Order Diptera; Family, Muscidæ.

A leaf miner was observed, in June, upon the cauliflower. A dozen plants growing in the shade were seriously injured; all the larger leaves were tunnelled and soon dropped off. Some of the plants finally died. Leaves were gathered and adult insects were reared from the mines.

Specimens were sent to Mr. D. W. Coquillett, who identified the insect as *D. flaveola*, the larvæ of which are found in the leaves of radish and turnip. Mr. Coquillett has given a brief account of this leaf miner in Insect Life, vol. vii, p. 381.

* Insect Life, vol. v, p. 224.

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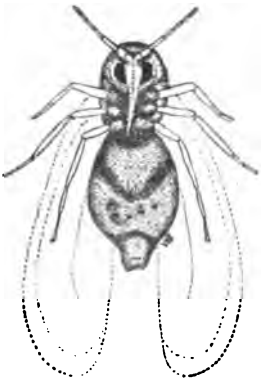
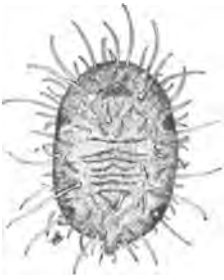


a.



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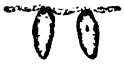

c.

d.

PLATE III. ALEYRODES VAPORARIORUM.

a. Adult magnified 51 diameters. *b.* Full grown larva. *c.* Eggs. Larva and eggs magnified 34 diameters, (original). *d.* Tomato leaf showing larvæ, (from photograph).

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The adult is a two-winged fly, which deposits eggs in the tissues of the leaf. No experiments have as yet been made relative to a treatment for this leaf miner, but it is always wise to destroy all infested leaves. Mr. Coquillett writes me that so far as he is aware, this insect has not previously been reported as attacking the cauliflower.

CABBAGE PLUSIA ON TOMATOES IN THE GREENHOUSE.

(*Plusia brassicæ*, Riley.)

Order, Lepidoptera; Family, Noctuidæ.

On the morning of October 16th, green caterpillars were noticed in the forcing-house devouring the foliage of tomato plants, which were then about two feet in height. Fourteen of these caterpillars were found that day. Search was kept up for some time, but none were discovered after October 23d, twenty-five in all having been taken in the tomato-house during one week.

The larvæ were placed in a glass jar and fed with tomato-leaves, which they consumed voraciously. They were nearly all about full-grown and shortly began to pupate—one, in fact, changed on October 17th, the next day after imprisonment. They did not remain long in the pupal state. The warm air of the laboratory was favorable to development, and probably hastened the appearance of the adults, which came forth on October 31st and November 1st.

The insect proved to be the "Cabbage Plusia," the larvæ of which are quite common upon cabbages in the Southern, Central, and Middle-Atlantic States. Sometimes, in the absence of the cabbage, this insect attacks other vegetables, including celery, cauliflower, turnip, lettuce, dandelion and tomato.

The full grown larva is from 25 to 33 mm. (1 to 1⅜ inches) in length, and 4 mm. in thickness at the thickest part, which occurs at the eighth segment. The color, above, is light green, indistinctly striped with white. The under surface is of a brighter green. There are two pairs of abdominal pro-legs. Though *Plusia* is a genus of *Noctuidæ*, the larvæ "loop" in traveling, much like Geometer larvæ; this is said to be due to the absence of front pro-legs. The full grown larva spins a white silken cocoon, usually on the under surface of the leaf, and becomes a brownish pupa. In about two weeks the adult emerges. The adult is a

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dark gray moth, each front wing having a silvery U-shaped spot near the middle.

Very likely the larvæ were feeding upon cabbages that grew in the garden near the forcing-house. They probably sought shelter from the cold, found their way indoors, where they at once began feeding, and where, if they had been allowed to remain, for a few hours even, they would have seriously injured several tomato plants by consuming the leaves.

THE RASPBERRY ROOT GALL-FLY.

(*Rhodites radicum*, Sacken.)

Order, Hymenoptera: Family, Cynipidæ.

The latter part of August, raspberry roots were received from Mr. C. C. Jones of Marlborough, Hartford County, Conn., which were covered with galls. Mr. Jones wrote: "I set some raspberry plants a year ago last spring and they are all dying. I send you a sample as they appear at the present time, and you will notice that there are worms at the roots. I set out some this spring and they are going the same way."

The injury is probably caused by the Raspberry Root Gall-Fly, which in its larval state produces rounded, warty galls, sometimes two inches in diameter, upon the roots of the raspberry, blackberry and rose. See plate IV.

These galls contain numerous cavities with a pithy substance intervening. Larvæ were found in these cavities. Plants attacked soon appear sickly and finally die.

There seems to be no remedy for the injury caused by this insect except to destroy the galls, and if plants are very badly infested they should be carefully dug up and burned.

The adult of this insect is a small four-winged fly about one-seventh of an inch in length. The head, thorax and abdomen are usually black, sometimes brown, with silky luster, and the feet are dark red.

According to Webster* these galls were first described by Harris† as being made by *Cynips semipicea*, Harr., but Sacken states that *C. semipicea* is not the cause of the gall and is probably a parasite of *R. radicum*.

* Ohio Exp. Station Bull. 45, p. 156.

† Insects Injurious to Vegetation, p. 549.

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PLATE IV. RASPBERRY ROOT-GALLS.

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THE CABBAGE ROOT MAGGOT.

(*Phorbia brassicæ*, Bouché.)

Order, Diptera: Family, Muscidæ.

The cabbage root maggot was reported as being injurious to cabbages in the town of Orange, Conn., during the latter part of May, 1895. The writer visited the fields of Mr. J. J. Merwin on May 25th and found fully two-thirds of the plants upon three acres of ground infested, while a large number of plants were seriously injured and a few had been killed. Other fields in the vicinity were also infested.

An application of lime and liquid manure (5 pecks of fresh lime slacked in 100 gallons of liquid manure) was advised for a part of the plants, in hope that the lime might kill the maggots, while the manure would stimulate the plants to outgrow the injury.

The owner began this treatment, but soon discontinued it, thinking the cost more than his plants were worth.

A "McGowen Injector"* was then procured and carbon bisulphide applied to 106 plants on June 4th. At this time the injury had gone so far that little or no benefit to the present crop could be derived from this treatment, which might, however, somewhat lessen the next year's brood of maggots.

Mr. Merwin finally lost about two-thirds of the plants on one field and one-third of those on another. On a third field, however, the cabbages suffered little, except that they did not head as early as where unattacked.

Mr. Merwin reports that he was unable to detect any difference between plants that were treated and those untreated, but thinks that the treatment would have proved beneficial had the applications been made earlier in the season when the larvæ first appeared.

An excellent account of this insect is given in the Cornell Station Bulletin 78, already referred to.

* Figured and described by M. V. Slingerland in N. Y. Cornell Station Bulletin 78, p. 533.

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THE ELM LEAF-BEETLE (*Galeruca xanthomelæna*).*

Numerous inquiries have reached us lately regarding this insect, which is proving destructive to elm trees in many parts of the State. The beetle (see *c*, *k*, in the accompanying cut) deposits its eggs, *a*, *e*, in small clusters on the lower side of the young leaves early in June, the larvæ hatch out in about a week and at once begin feeding upon the leaves. These larvæ, *b*, *g*, are small worms about five-eighths of an inch long, marked on each side with a broad blackish stripe. They are soft, moist, and some-

ELM LEAF-BEETLE.—*a*, eggs; *b*, larvæ; *c*, adult; *e*, eggs, enlarged; *f*, sculpture of eggs; *g*, larva, enlarged; *h*, side view of greatly enlarged segment of larva; *i*, dorsal view of same; *j*, pupa, enlarged; *k*, beetle, enlarged; *l*, portion of elytron of beetle, greatly enlarged. (*After Riley.*)

* This article was published in July, 1895, in Station Bulletin 121. It is here reprinted in slightly amended form. As to authorship, while Messrs. Britton, Sturgis, Jenkins and Johnson have each contributed some paragraphs, the natural history and treatment have been mostly compiled from the writings of Messrs. Howard and Smith.

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what hairy to the touch. It is at this stage that the insect is most destructive, eating off the delicate surface tissue of the leaves, and causing the latter to become shrivelled and brown, and eventually to fall from the tree. By the end of June or early in July the worms become full grown. They then crawl down or fall from the trees and, in crevices of the bark or soil or under grass and leaves, change to soft, yellowish pupæ, *j*. Ten days later the pupæ give rise to the adult insects, small yellowish beetles, *c*, *k*, about one-quarter of an inch in length, marked on the back with two black stripes. The beetles ascend the tree and for a month feed upon the remaining leaves, though the injury done by them is much less than that due to the worms. During August and the early part of September the beetles enter cracks or crevices, where they hibernate, remaining until late in May, when they gather upon the young leaves to deposit their eggs. In New England there appears to be but one brood during the season.

Methods of Extermination.—This insect can best be destroyed in the larval and pupal conditions. The larvæ (worms) are found in June and July upon the leaves, the pupæ in July upon the trunks of the trees and on, or in, the ground beneath the trees.

The best method of combatting the Elm Leaf-Beetle is to spray the foliage with an arsenical poison.

Lead arsenate is better for this purpose than Paris green* because it stays longer in suspension and is less injurious to foliage. It is easily prepared from eleven ounces of sugar of lead (lead acetate), four ounces of sodium arsenate,† and one hundred gallons of water.

Throw the sugar of lead by itself into an empty hogshead and add 99 gallons of water, stirring with a paddle so as to mix the whole thoroughly. In another vessel dissolve the sodium arsenate in one gallon of water. Finally mix the two liquids together by effectual stirring, when the lead arsenate will appear as a fine white powder. In using this mixture the lead arsenate must be kept uniformly in suspension by suitable agitation.

* Both these dangerous substances contain arsenic and require caution in handling, but may be used without serious injury if not swallowed or introduced into wounds.

† To be had of Billings, Clapp & Co., Boston, for eight cents a pound in 25 pound quantities.

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A serviceable spraying mixture may also be made by mixing one pound of Paris green and three pounds of lime with one hundred and fifty gallons of water. The lime should be newly slaked and strained free from grit or lumps.

If the Paris green is not kept uniformly mixed with the other materials, by thorough agitation of the entire contents of the tank, while spraying, it will partly settle to the bottom, and the last portions of spray will be likely to "burn" the foliage. The addition of two quarts of molasses or a little flour paste to these drenches will make the poison adhere to the foliage for a long time, thus rendering sufficient a smaller number of sprayings.

To reach the tops of high trees a powerful force pump and a long hose are necessary. The Douglas Palmetto spraying pump, manufactured by W. & B. Douglas, Middletown, Conn., is well adapted to this purpose when hand-power is employed. It should be mounted upon a cask and raised as high as possible above the ground. The discharge pipe should be a half-inch rubber hose, supported on a light pole, so that the spray can be directed well up into the trees.

While a few trees may be cared for by the use of a hand-pump, the many full-grown elms in our large villages and cities require much more powerful appliances.

In 1894, Mr. Stephen Hoyt, of New Canaan, Conn., had a steam spraying outfit* constructed, by the use of which the trees upon the estate of Stephen Hoyt's Sons have been treated for two seasons with success.

From their experience, kindly communicated and illustrated to us in all details, we are enabled to present the following plan of treatment by power, adapted for use on a large scale.

A portable steam engine of eight, ten, or more horse-power with a double-acting force pump and a tank of 300 or more gallons capacity, are mounted on a stout wagon with a platform large enough to accommodate the engineer.

The force-pump should be supplied with an indicator to show the water-pressure, and a number of outlets, two, four, or more, to connect with as many lines of hose as may be practicable. Suitable hose, guaranteed to stand 200 lbs. pressure to the inch and costing 12 cents per foot, may be got of the Mineralized Rubber Co., 18 Cliff st., N. Y. The Lightning Hose Coupling is recommended.

* See Mr. Hoyt's letter, appended.

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To each hose is attached a nozzle adapted for producing a fine spray. A good nozzle for use with power is the McGowen, made by J. J. McGowen, Ithaca, N. Y., costing $1.50. This with 180 lbs. steam pressure throws a shower of fine spray vertically through thirty feet or more of still air.

The tank, to be charged with the poison drench, should be provided with an agitator to keep the materials in the tank uniformly mixed. Through the kindness of Mr. Hoyt we are able to show pictures of his outfit in the accompanying plate.

Besides the horses needful to bring the apparatus into position, a driver who can operate the agitator, an engineer, four, six or possibly eight men to manage as many lines of hose, and an assistant to charge the tank, are the needful force.

A man with "creepers" ascends a tree, carrying a stout cord, and choosing a good position in a crotch, hauls up a line of hose and fastens it to a limb, so that, holding the hose near the end, he can direct the nozzle on all sides. The power being applied, the water, with the poison in suspension, is forced out of the hose in a shower of fine spray, which, by skillful handling of the nozzle, is quickly applied to all parts of the foliage. To avoid waste of liquid the spray is thrown for a moment only on any one point, one, two or three minutes, at the most, sufficing to finish work on large trees.

While two or more men are directing the spray into as many trees, the same number are climbing the adjacent trees, so that the engine and its attendants are fully occupied.

Two treatments are advisable, the first in May as soon as the leaves are half grown, in order to destroy the beetles before they deposit their eggs; the second in June or as soon as it is seen that the eggs which have been laid are hatching out. This is undoubtedly the most effective means of destroying the insect, and should be kept up for several years.

If, for any reason, the spraying of the trees is impracticable, efforts must be made to destroy the insects in the pupal condition on or beneath the trees. This is best done by the use of kerosene emulsion, which is made as follows: Dissolve one-half pound of common hard soap in one gallon of boiling water; to this soap solution, while still hot, add two gallons of kerosene, and churn violently for five minutes until a creamy emulsion results, p. 202. Mix this with nine times its bulk of cold water by stirring, and sprinkle the thus diluted emulsion over the ground through a

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watering-pot. The application, which is not injurious to grass, should be made in such a quantity as to saturate the soil where the pupæ exist. By carefully examining the ground, grass, fallen leaves, etc., beneath the trees, the pupæ can be found, and the proper time for applying the emulsion as well as the extent of ground demanding treatment can be ascertained. In this climate the soft, yellow pupæ will be found on the ground from the middle of June to the middle of July or later, according to the season. The emulsion should be applied as soon as they are observed and the application repeated if needful to destroy them. To be thoroughly effective, this method of destroying the pupæ must be practiced each year.*

It is well to scrape away the rough outer bark of the trees for some distance above the ground, as many pupæ are likely to be concealed in the crevices. The scrapings should be burned or drenched with kerosene.

The worms which descend the trunk of the tree to pupate may be easily and almost completely intercepted by a band of hay an inch thick and 8 inches wide, secured to the scraped trunk at convenient height from the ground, by aid of a 6 in. girth of cheap cotton cloth, which is first tacked by one end to the bark and after packing the hay under it around the tree, is fastened at the other end by pins.

As often as the hay gets stocked with worms and pupæ it should be removed and burned, adding kerosene, if necessary, and a new hay band put in its place. If in the process of removal, pupæ have dropped to the ground they may be killed with kerosene emulsion.

The following letter from Mr. Hoyt, addressed to the Director, in answer to a request for some particulars concerning his spraying outfit, will prove useful.

DEAR SIR:—In reply to yours would say, the boiler was made by Chas. W. Foster, in New Haven, and will generate steam sufficient to produce five or six h. p., at a pressure of 100 lbs. The cost was $200. The pumps were made by the Marsh Steam Pump Co., Battle Creek, Mich. We got two pumps, size BB, and intended to run them both for spraying. I had one arranged to feed the boiler and to spray also, but found this did not work satisfactorily, so bought

* While the touch of very little kerosene to the bodies of larvæ and young pupæ is fatal, the emulsion may fail to destroy hairy worms or older pupæ, because the hairs of the former or the chitinous coverings of the latter, shield the soft and vulnerable parts from actual contact with it.

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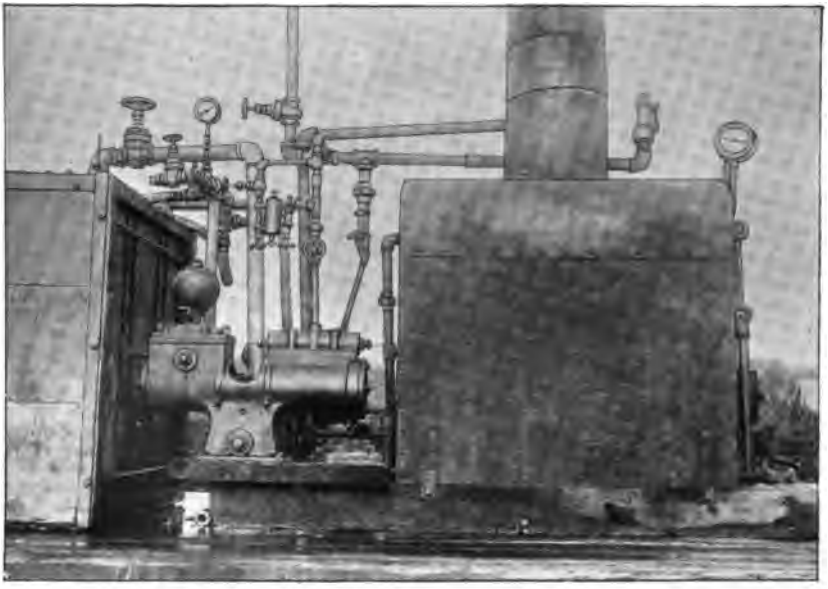

Arrangement of Engine, Pumps and Tank, for Spraying Large Trees.

Engine throwing Spray under pressure of 150 pounds to square inch.

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another, two sizes larger (size D), using the smaller pump for boiler feed only. The BB size is quoted at $50 less 50%. This is too large for a feed pump to a boiler of this capacity, and did we not have it, would have bought the smaller size, which is quoted at $30, less 50%.

Our 300 gallon tank was made by Geo. F. Johnson, New Canaan, Conn., and is partitioned off to hold 75 gals. of water to feed the boiler, and 225 gals. of mixture for spraying. This tank was bolted and ironed all through, and cost $40. Our hose, from the Mineralized Rubber Co., was ½"; but we advise getting ¼" hose, as the strain is not so great, nor is it so heavy to handle. We used two lines of hose each 100 feet long. The McGowen nozzle does very good work, and is quite economical with the solution. We also found the Daisy nozzle, made in New Haven, excellent for tree spraying.

Although our boiler uses coal or wood for fuel, we bought it partly for another purpose, and would advise for spraying simply, to use a boiler heated by oil, as much more convenient. For a boiler feed-pump would suggest the Marsh, size B, and for spraying, a duplex high service pump, or one that would give a pressure of at least 150 lbs., such as are made by Worthington, Dean, Knowles or Snow.

The total cost of an outfit would average from $275 to $375, according to size.

Yours very truly,

STEPHEN HOYT, New Canaan, Conn.

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ON A FRAUD IN MILK.

By E. H. Jenkins.

Four samples of milk, stated to have been supplied by a certain dairy, were sent to this Station, in June, 1895. They were tested with the following results:

	A.	B.	C.	D.
Specific Gravity	1.032	1.030	1.033	1.029
Solids, per cent.	11.09	10.47	11.36	9.68
Fat, per cent.	2.20	2.25	2.70	2.20
Solids not Fat, per cent.	8.89	8.22	8.66	7.48

The solids are below the normal average by one to three per cent. and the fat is too little by more than one per cent. These facts indicate removal of fat and addition of water; but the specific gravity is that of normal milk. Such exceptional milk might be the product of a single cow, perhaps, but that any herd of healthy animals can give such milk is contrary to all recorded experience.

The sender was advised to witness the milking of the herd and to send for analysis another fully authenticated sample.

Two days later we received two samples with the message:— "These two bottles were filled at the barn by a man who saw the whole process. He says he is sure there is no water in it." Examination of these samples gave the following results:

	A.	B.
Specific Gravity	1.0325	1.033
Solids, per cent.	11.00	11.29
Fat, per cent.	2.60	2.65
Solids not Fat, per cent.	8.40	8.64

We wrote, asking for the name and address of the witness present at the milking that we might get from him further particulars and an affidavit. In reply we were informed that the witness had since mentioned that "when the cows were about half milked, the calves were turned in to feed and finish the milking"!

The quality of these samples of "milk" is quite what would be expected under such circumstances.

It is well known that the portions of milk first drawn from the udder are watery and poor in fat and other solids, while the last

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portions are rich in solids and fat. The following figures by Bouchardat and Quevenne* illustrate the extent of this difference. The milk of three cows, I, II and III, which gave 20, 14 and 20 liters (quarts†) respectively, was examined with results as follows:

		Per cent.				
	Sp. Gr.	Water.	Fat.	Casein.	Sugar.	Total Solids.
I. First Liter	1.034	89.51	1.40	3.87	5.18	10.45
I. Last Liter	1.026	83.82	7.37	4.09	4.72	16.18
II. First Half	1.034	88.47	1.79	4.12	5.62	11.53
II. Last Half	1.031	86.61	4.36	3.96	5.07	11.39
III. First Liter	1.031	89.81	0.85	3.64	5.70	10.19
III. Last Liter	1.027	84.95	6.39	3.35	5.31	15.05

Harrington (Report of Mass. Board of Health for 1889, p. 189)* found in milk of a Jersey cow:

	Per cent.		
	Water.	Fat.	Total solids.
In "fore milk"	86.66	3.88	13.34
In "middle milk"	84.60	6.74	15.40
In "strippings"	82.87	8.12	17.13

Allowing calves to take a part of the milk is a common and, in itself, proper practice; but any one who sells the first of the milking as whole milk, grossly defrauds the purchaser. This case is interesting in calling attention to a possible dishonesty which is not always fully and certainly met by legislation.

* Quoted from Zusammensetzung und Verdaulichkeit der Futtermittel, von Dietrich und König, pp. 837, 838.

† 100 liters equal 105 quarts.

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OBSERVATIONS ON THE GROWTH OF MAIZE CONTINUOUSLY ON THE SAME LAND FOR EIGHT YEARS.

By E. H. Jenkins.

In the years 1888 and 1889 a parcel of land containing 1½ acres which had been a meadow for some years previous, was dressed with commercial fertilizers and planted to corn. Fertilizers and crops were weighed and analyzed each year and the enrichment of the soil by the dressing or its exhaustion by the cropping were determined as accurately as possible.

In the spring of 1890 this land was divided into four strips, each containing three-tenths of an acre, and was dressed as shown in the following diagram.

South.	Plot A.—Cow Manure at the rate of 10 cords per acre.	North.
	Plot B.—Hog Manure at the rate of 13½ cords per acre.	
	Plot C.—Fertilizer Chemicals at the rate of 1700 pounds per acre.	
	Plot D.—No manure or fertilizer of any kind.	

Corn was planted in drills four feet apart and the stalks stood singly at distances of ten inches in the drill. The crop from each plot was separately weighed and analyzed.

Since 1890 the several plots have annually received the same dressing and have been under the same conditions of planting, cultivation and harvesting as in that year.

Full particulars regarding the details of the experiment and the results obtained from year to year will be found in the Reports of this Station for 1890, pages 183 to 194; 1891, pages 139 to 149; 1892, pages 122 to 129; 1893, pages 286 to 300; 1894, pages 245 to 253.

In the following paragraphs are placed on record the results of the observations for the year 1895.

Discussion of the results is reserved.

Considering simply the gross amounts of nitrogen, phosphoric acid and potash which the dressing added to the soil of the sev-

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eral plots and those which the crops removed, it appears from Table VII, to be noticed later, that, after the crop of 1895 was harvested, there had been added to plot A *per acre, in excess of what had been taken off in crops,* 1148 pounds of nitrogen, 788 of phosphoric acid and 799 of potash, all from cow manure.

The corresponding enrichment of plot B consisted, *per acre,* of 1879 pounds of nitrogen, 3446 of phosphoric acid and 64 of potash, all from hog manure. The very large excess of phosphoric acid in the hog manure is due to the fact that the hogs were fed chiefly on hotel garbage, which contained a large quantity of bones of fowls.

The enrichment of plot C, *per acre,* amounted to 520 pounds of nitrogen, 972 of phosphoric acid and 177 of potash, all from fertilizer-chemicals.

Plot D received fertilizer-chemicals in 1888 and 1889, but in the following six years no dressing of any sort; so that after the harvest of 1895 it had acquired, *per acre,* 54 pounds more of phosphoric acid (from the applications of 1888 and 1889), than the crops had removed, but had lost 316 pounds of nitrogen and 66 pounds of potash.

Plot B also received more "organic matter" from the dressing than plot A, while plot C acquired only an insignificant amount in the dressing of fertilizer-chemicals, and plot D none at all.

Plot A receives annually about 3,207 pounds, plot B about 5,440 pounds and plot C not more than 200 pounds of organic matter.

Gross Yield of the Plots in 1895.

Table I presents the gross weight of the kernels, cobs and stover harvested on each plot. Inasmuch as the kernels were air-dried on the cob, the weight of the latter in the field-cured condition could not be taken. Hence the weight of the kernels given in the table is slightly too high and that of the cobs slightly too low. But the error is small.

Table I.—Gross Yield of the Plots, Pounds per Acre.

	Plot A. Cow Manure.	Plot B. Hog Manure.	Plot C. Chemicals.	Plot D. No Fertilizer.
Kernels	4890.5	5255.7	3895.0	2026.5
Cobs	674.5	684.3	560.0	268.5
Stover	7215.0	7950.0	4125.0	2235.0
Total	12,780.0	13,890.0	8580.0	4530.0

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Since these crops contain a large and variable quantity of water, a strict comparison of the yields can only be made on the dry matter.

This appears in Table II.

TABLE II.—DRY MATTER OF THE CROPS, POUNDS PER ACRE. 1895.

	In Kernels.	In Cobs.	In Stover.	Total.
Plot A, cow manure	3155.4	602.3	3650.1	7407.8
Plot B, hog manure	3370.0	611.1	4032.2	8013.3
Plot C, fertilizer chemicals	2446.8	500.1	2428.4	5375.3
Plot D, no fertilizer	1186.5	239.8	1416.0	2842.3

During the last six years there has been no striking difference in the crops of these four plots, as far as the proportions of kernels, cobs and stover are concerned, unless perhaps the crop on D, which received neither fertilizers nor manure for six years, had a rather larger proportion of stover than the others. The figures are as follows :

TABLE II[a].—PERCENTAGE OF WATER-FREE KERNELS, COBS AND STOVER, IN THE CROPS. AVERAGE OF SIX YEARS.

	Plot A.	Plot B.	Plot C.	Plot D.
Kernels	44.2	44.3	45.4	42.5
Cobs	7.8	8.0	9.0	7.7
Stover	48.0	47.7	45.6	49.8
	100.00	100.00	100.00	100.00

Excess of nitrogen has not made the crop "run to leaves" nor has deficiency of plant food strikingly affected the relative proportion of ears and stalks.

The relative yields of dry matter from these plots for the last six years are given in Table III, the yield of plot A being marked in each case as 100.

TABLE III.—RELATIVE YIELD OF DRY MATTER FROM PLOTS A, B, C, D FOR SIX YEARS.

	Plot A.	B.	C.	D.
1890	100	104.7	89.5	73.5
1891	100	92.9	82.0	65.9
1892	100	114.6	98.3	48.9
1893	100	95.1	73.2	43.1
1894	100	95.6	96.9	66.9
1895	100	108.2	72.6	38.4
Average	100	101.8	85.4	56.1

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It thus appears that during six years the two plots A and B, which were dressed with heavy applications of manure, have yielded on the average the same amount of water-free crop.

Plot C, dressed with fertilizer chemicals, supplying considerably more nitrogen, phosphoric acid and potash yearly than the crop removed, yielded on the average more than eight-tenths as much, and plot D, without fertilizers, yielded between five and six-tenths as much as plots A and B.

The relative yield on plot D fell steadily till 1894, when it rose very considerably, to drop again in 1895.

This would indicate that plot D suffered less from the prolonged drought of the summer of 1894 than the plots which had been dressed with manure for a term of years and which contained much more humus.

During five years there was a pretty regular falling off from year to year, in the yield of all four plots, as is shown in Table III[a], in which the yield of dry matter for each plot in 1890 is marked as 100; but in 1895 all the plots yielded more than in either of the two preceding years. In 1893 and 1894 crops, in this region generally, suffered more from drought than in 1892 or 1895.

TABLE III[a].—RELATIVE YIELD OF DRY MATTER IN THE SIX YEARS, 1890 TO 1895.

	Plot A.	Plot B.	Plot C.	Plot D.
1890	100	100	100	100
1891	96	81	83	81
1892	79	87	88	53
1893	58	53	48	34
1894	44	41	48	41
1895	82	85	67	43

The diminished yield of plot D is no doubt in part due to lack of plant food. In the other cases this cause cannot have been operative, except in reference to water supply.

YIELD OF EACH FOOD INGREDIENT.

In Table IV are given the quantities, in pounds per acre, of each food ingredient harvested from the four plots in 1895.

The cobs were not analyzed, but as their amount is relatively very small, the average composition of cobs as determined in other analyses, is used for the calculation.

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TABLE IV.—YIELD OF FOOD INGREDIENTS IN POUNDS PER ACRE. 1895.

	PLOT A.				PLOT B.				PLOT C.				PLOT D.			
	Kernels.	Cob.	Stover.	Total.	Kernels	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.	Kernels.	Cob.	Stover.	Total.
Water	1735.1	72.2	3564.9	5372.2	1885.7	73.2	3917.8	5876.7	1448.2	59.9	1696.6	3204.7	840.0	28.7	819.0	1687.7
Ash	41.1	9.4	232.3	282.8	52.0	9.6	288.6	350.2	31.5	7.8	127.9	167.2	15.4	3.8	63.0	82.2
Albuminoids	370.2	16.2	257.6	644.0	411.0	16.4	267.1	694.5	282.3	13.4	144.4	440.1	109.4	6.4	65.9	181.7
Fiber	56.2	203 0	1222.2	1481.4	53.6	206.0	1400.8	1660.4	46.0	168.7	867.1	1081.8	22.5	80.8	485.0	588.3
Nitrogen-free extract	2525.5	370 3	1887.4	4783.2	2674.2	375.7	2019.3	5069.2	1963.1	307.4	1256.0	3526.5	982.5	147.4	782.0	1911.9
Fat	162.4	3.4	50.6	216.4	179.2	3.4	56.4	239.0	123.9	2.8	33.0	159.7	56.7	1.4	20.1	78.2
	4890.5	674.5	7215.0	12,780.0	5255.7	684.3	7950.0	13,890.0	3895.0	560.0	4125.0	8580.0	2026.5	268.5	2235.0	4530.0

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TABLE V.—COMPOSITION, PER CENT., OF FIELD-CURED MAIZE, KERNELS AND STOVER, FROM PLOTS A, B, C, D. 1895.

	Analyses of Field-cured Maize.						Calculated Water-free.				
	Water.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.	Ash.	Albuminoids.	Fiber.	Nitrogen-free Extract.	Fat.
KERNELS.											
Plot A	35.48	.84	7.57	1.15	51.64	3.32	1.30	11.73	1.78	80.04	5.15
Plot B	35.88	.99	7.82	1.02	50.88	3.41	1.54	12.19	1.59	79.36	5.32
Plot C	37.18	.81	7.25	1.18	50.40	3.18	1.29	11.55	1.88	80.22	5.06
Plot D	41.45	.76	5.40	1.11	48.48	2.80	1.30	9.23	1.90	82.79	4.78
STOVER.											
Plot A	49.41	3.22	3.57	16.94	26.16	.70	6.38	7.05	33.49	51.69	1.39
Plot B	49.28	3.63	3.36	17.62	25.40	.71	7.16	6.63	34.75	50.06	1.40
Plot C	41.13	3.10	3.50	21.02	30.45	.80	5.24	5.95	35.71	51.75	1.35
Plot D	36.65	2.83	2.95	21.68	34.99	.90	4.47	4.66	34.23	55.22	1.42

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The yield of each food ingredient from the four plots shows, in general, differences like those already noted in respect to the yield of total dry matter.

Table V shows the composition of the crops on the four plots, A, B, C and D, for the year 1895.

Table VI exhibits the striking differences in the percentage composition of the crop on the four plots calculated from the average of six years.

The crops, both of kernels and stalks, on A and B, which have been very heavily dressed each year, the one with cow manure, the other with hog manure, are practically identical as regards chemical composition.

The kernels of the crop on C, which receives each year a liberal dressing of fertilizer chemicals, 1500 pounds to the acre, contains in the kernels somewhat less ash or mineral matter and fat, and half a per cent. less of proteids, etc.,* than the crops on A and B, with correspondingly more nitrogen-free extract. Similar differences are found in the composition of the stalks.

The kernels in the crop on D, to which no fertilizer or manure has been applied since 1889, have 2.3 per cent. less proteids, etc., than that of plots A and B, somewhat less ash and fat, but more fiber and nitrogen-free extract.

TABLE VI.—AVERAGE COMPOSITION OF THE DRY MATTER OF KERNELS AND STOVER OF CROPS OF 1890, 1891, 1892, 1893, 1894 AND 1895.

	Ash.	Proteids, etc.*	Fiber.	Nitrogen-free Extract.	Fat.
		KERNELS.			
Plot A	1.35	11.50	1.74	80.16	5.25
Plot B	1.48	11.61	1.64	80.00	5.27
Plot C	1.28	11.08	1.81	80.74	5.09
Plot D	1.27	9.38	1.88	82.62	4.85
		STOVER.			
Plot A	6.59	6.73	33.15	52.09	1.44
Plot B	6.81	6.63	33.67	51.43	1.46
Plot C	5.87	6.30	34.21	52.24	1.39
Plot D	5.21	5.34	33.50	54.51	1.44

To complete the data regarding this experiment two other tables are presented.

* i. e. Nitrogen reckoned as proteids (including albumin, globulin, zein) and also amides and other compounds of nitrogen.

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Table VII gives the quantities of nitrogen, phosphoric acid and potash which were added in the manure or fertilizers and remained in the crops of 1895.

It also gives the amounts of those fertilizing materials which have been added to the soil capital (+) or withdrawn (−) in the eight years during which accurate account has been kept.

Table VIII gives the record of the crops on the four plots for the whole period covered by the experiment and also the percentage composition of the several crops.

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TABLE VII.—ENRICHMENT OR IMPOVERISHMENT OF SOIL BY EIGHT YEARS' MANURING AND CROPPING WITH INDIAN CORN. POUNDS PER ACRE.

	Cow Manure. Plot A.			Hog Manure. Plot B.			Fertilizer Chemicals. Plot C.			No Fertilizer. Plot D.		
	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.	Nitrogen.	Phos. acid.	Potash.
After seven years' cropping	+934.6	+680.7	+711.7	+1571.0	+2898.0	+101.3	+418.6	+831.4	+158.7	−287.5	+65.4	−54.3
Applied in 1895	286.3	136.4	204.5	419.9	586.5	72.4	172.0	162.0	69.0	00.0	00.0	00.0
Taken off in Crop of 1895	103.0	29.0	117.1	111.1	38.5	109.8	70.4	21.8	50.3	29.1	11.6	11.7
Excess (+) or Deficiency (−) after eight years' cropping	+1117.9	+788.1	+799.1	+1879.8	+3446.0	+63.9	+520.2	+971.6	+177.4	−316.6	+53.8	−66.0

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TABLE VIII.—YIELD OF DRY MATTER AND "SHELLED CORN" PER ACRE FOR EIGHT YEARS AND COMPOSITION OF DRY MATTER.

	Year.	Distance of Planting.	Pounds of Dry Matter per Acre.	Bushels of Shelled Corn.	Percentage Composition of Dry Matter				
					Ash.	Proteids, etc.*	Fiber.	Nitrogen-free Extract.	Fat.
Fertilized alike with chemicals	1888	Stalks 12 inches apart.	7350	75	3.3	7.8	19.4	66.1	3.4
	1888	" 6 " "	7980						
	1889	" 12 " "	6144	60	3.5	6.1	21.7	69.7	3.0
	1889	" 6 " "	6353						
Cow Manure	1890A	" 10 " "	9014	91	4.0	7.9	19.8	65.7	2.6
Hog Manure	1890B	" 10 " "	9436	97	4.2	8.0	19.6	65.5	2.7
Fertilizer Chemicals	1890C	" 10 " "	8070	87	3.9	8.0	21.2	64.4	2.5
No Manure or Fertilizer	1890D	" 10 " "	6626	51	3.8	6.2	20.7	66.7	2.6
Cow Manure	1891A	" 12 " "	8176	103	3.2	7.5	15.5	70.2	3.6
Hog Manure	1891B	" 12 " "	7599	88	3.3	7.6	16.2	69.3	3.6
Fertilizer Chemicals	1891C	" 12 " "	6708	70	3.2	6.4	18.5	68.8	3.1
No Manure or Fertilizer	1891D	" 12 " "	5391	60	3.1	6.0	17.4	70.2	3.3
Cow Manure	1892A	" 12 " "	7181	72	4.0	8.2	19.6	65.1	3.1
Hog Manure	1892B	" 12 " "	8233	84	4.0	8.8	19.3	64.8	3.1
Fertilizer Chemicals	1892C	" 12 " "	7062	86	3.2	8.3	17.5	67.8	3.2
No Manure or Fertilizer	1892D	" 12 " "	3509	38	3.3	7.7	18.8	67.2	3.0
Cow Manure	1893A	" 12 " "	5277	53	4.3	8.8	20.8	63.3	2.8
Hog Manure	1893B	" 12 " "	5020	52	3.8	8.4	21.1	63.9	2.8
Fertilizer Chemicals	1893C	" 12 " "	3858	37	3.8	9.0	21.6	63.0	2.6
No Manure or Fertilizer	1893D	" 12 " "	2277	18	4.6	8.2	22.5	62.4	2.3
Cow Manure	1894A	" 12 " "	4021	42	4.3	9.0	18.8	64.5	3.4
Hog Manure	1894B	" 12 " "	3845	40	4.2	9.2	18.1	65.2	3.3
Fertilizer Chemicals	1894C	" 12 " "	3898	42	4.3	8.7	18.2	65.5	3.3
No Manure or Fertilizer	1894D	" 12 " "	2691	27	3.6	7.2	20.0	66.2	3.0
Cow Manure	1895A	" 12 " "	7408	75	3.8	8.7	20.0	64.6	2.9
Hog Manure	1895B	" 12 " "	8013	80	4.4	8.7	20.7	63.2	3.0
Fertilizer Chemicals	1895C	" 12 " "	5375	58	3.1	8.2	20.1	65.6	3.0
No Manure or Fertilizer	1895D	" 12 " "	2842	28	2.9	6.4	20.7	67.3	2.7

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POULTRY FOODS.

The following brands of Poultry Food were sent to this Station for examination by J. S. Adam, of Canaan:

4516. Bradley's Superior Meat Meal, stated to be made of beef, blood and bones. Made by the Bradley Fertilizer Co., Boston, Mass.

4517. Bowker's Animal Meat, stated to be made from fresh beef and fresh bones, which are dried and cooked by steam and then ground. Made by the Bowker Fertilizer Co., Boston, Mass.

4518. Breck's Poultry and Swine Meal. "In addition to the pure meat and bone we have combined in this preparation some of the most potent agents known for the production of eggs, not by stimulating, but rather by preventing disease and promoting general good health," etc. Made by Joseph Breck & Sons, 47 N. Market St., Boston, Mass.

4519. C. A. Bartlett's O. K. Feed. Stated to be made of material daily collected from the city butcher markets and cooked while perfectly fresh. It is then pressed, dried by steam heat and ground fine. Made by C. A. Bartlett, Worcester, Mass.

4520. Smith & Romaine's Boiled Beef and Bone. Made by Smith & Romaine, 109 Murray St., N. Y. City.

The samples were purchased from the manufacturer with the exception of **4517**, which was bought of Ives & Pierce, Canaan, Conn.

ANALYSES.

	Bradley's. 4516	Bowker's. 4517	Breck's. 4518	Bartlett's 4519	Smith & Romaine's 4520
Moisture	5.03	4.81	12.86	4.69	5.13
Fat	11.37	11.50	10.95	11.50	13.75
Protein *	36.62	41.75	29.81	40.68	38.00
Other Volatile and Organic Matters	3.72	4 49	4.90	5.49	5.15
Phosphate of Lime†	36.89	30.82	25.50	31.23	33.38
Sand and Soil	1.76	2.32	1.25	.57	1.03
Other Mineral Matters	4.61	4.31	14.73	5.84	3.56
	100.00	100.00	100.00	100.00	100.00
*Containing Nitrogen	5.86	6.68	4.77	6.51	6.08
†Containing phosphoric acid	16.86	14.11	11.67	14.29	15.27

The "protein" is calculated by multiplying the nitrogen found, by the factor, 6.25.

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All the preparations appear to consist chiefly of meat and bone having about the composition of "bone tankage," which is used as a fertilizer.

They are quite alike in composition excepting that Breck's Poultry and Swine Meal contains less protein and phosphate of lime than either of the others, and correspondingly more moisture and mineral matters, which consist in part of carbonate of lime.

ANALYSES OF FEEDING STUFFS.

Maize Kernel.

5443. Bloody Butcher Corn, a 16-rowed, red dent variety, grown in Guilford, from seed brought from Iowa. "It grows two feet higher here than at the west."

5442. Hearst Corn, a 14-rowed yellow dent, grown in Guilford, from Iowa seed.

5441. Early Sciota Corn, a 14-rowed dent, grown in Guilford.

The three samples just named were brought to the Station by Richard Wilcox, of Guilford. Analyses are given on page 231.

The Bloody Butcher variety contains decidedly more protein and correspondingly less nitrogen-free extract than the other two.

The sample of early Sciota corn contains less protein and more starch than corn of average composition. Fertilizers, climate and rate of planting all affect the composition of the maize kernel and probably have more effect than any differences of variety.

By fertilization, variations in weather conditions in a given locality during a course of years and rate of planting, greater differences may be caused in the composition of a single variety of maize kernel, than will be found in the composition of different varieties of dents or flints raised for a course of years under like conditions.

Gluten Meal and Gluten Feed.

These are bye-products of the manufacture of corn-starch and glucose:

4487. King Gluten, granulated. Sent by R. E. Holmes, West Winsted. Cost $22.00 per ton.

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4529. King Gluten, ground fine. Sent by Horace Burr, Winchester, to ascertain if it was pure.

5603. Gluten Meal. Made by Chicago Sugar Refining Co. Cost $14.75 in car lots.

5617. Atlas Gluten Feed. Made by Chicago Sugar Refining Co. Cost $15.50 in car lots.

5604. Gluten Meal. Made by National Starch Works, of New York City. Cost $15.50 per ton in car lots.

5605. Gluten Meal. Sold by Stein, Hirsch & Co. Hammond, Ill. Cost $14.90 per ton in car lots.

Nos. 5603, 5617, 5604 and 5605 were sampled and sent by T. A. Stanley, New Britain.

4488. Buffalo Gluten Feed. Sent by R. E. Holmes, West Winsted. Cost $19.00.

4486. Gluten Feed. Sold by Horace Burr, Winchester. Sent by R. E. Holmes, West Winsted. Cost $18.00.

The analyses given on page 231, show that the protein of "Gluten Feed" now ranges from 37 per cent. down to 17.8 per cent.

5603. Chicago Gluten Meal is the clear "gluten" from the settling tanks, containing little oil, but over 40 per cent. protein, only three per cent. less of this ingredient than cotton seed. The two feeds have about the same place in a cattle ration.

5604 and **4487** appear to consist of "gluten," mixed with maize "chits" or germs* which are rich in oil, thus lowering the per cent. of protein about two per cent. but increasing the fat to nearly 20 per cent. In general, feeds containing so large a proportion of fat are not easy to combine with others in a balanced ration.

5647. Contains besides gluten, the corn hulls, as shown by the larger per cent. of fiber, and probably also the chits.

"Buffalo Gluten Feed," **4488**, made by the American Glucose Co., of Buffalo, consists of all the parts of the kernel except the starch, which has been removed for conversion into glucose. It consists therefore, of the hulls, gluten, chits and oil, and has from year to year a pretty uniform composition.

Wheat Bran.

4505 and **4504.** Sent by W. H. Olcott, South Manchester, to learn which was the more concentrated feed. **4505** appeared to him to contain much less "middlings" (starchy matter?) than 4504.

* In some manufactories a good share of the oil is extracted from the chits before the latter are mixed with the gluten.

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The analyses show that **4505** contains 3½ per cent. more protein, 1½ per cent. more each of fat and of mineral matter, and 3¾ per cent. more of fiber than the other sample, but some 9 per cent. less of non-nitrogenous extract (starch).

Rice Flour.

4496 and **5510** are samples of refuse rice flour sold at the South for cattle food. Sampled and sent by Joseph D. Weed, Noroton, one sample in January, the other in November. The samples have the composition of a mixture of rice flour or "polish" with rice hulls. They contain about the same per cent. of protein as maize kernel with considerably more fiber and fat.

Miscellaneous Feeds.

5268. Barley Feed. Sent by W. H. Olcott, South Manchester. This contains over two per cent. more of protein and 7 per cent. more of fiber than maize kernel, the same amount of fat, but 10 per cent. less of nitrogen-free extract.

4566. Rye Bran. Sent by E. C. Birge, Southport.

The cows fed on this appeared to dislike it from the first and in two or three days after being put on the feed the herd, with one or two exceptions, were badly scoured and the milk-yield sunk one-third.

The determination of protein showed the average amount for rye bran, and we were unable to find anything which could explain the effects attributed to it.

4479. "Cattle Feed." A mixed feed, sold by C. A. Parsons, Boston, Mass., for $15.00 per ton in Boston.

The printed circular accompanying it claims for the feed that it is richer than shorts, "and contains the most nourishment for the money of anything you can buy, and no mistake."

It cost, delivered at East Bolton, $17.40 per ton, and was sampled and sent by A. H. Pomeroy, Coventry.

Assuming that this mixture contains no refuse material of any kind but is made of sound grain or mill products, it is not nearly as concentrated or "rich" a feed as wheat bran, as a comparison of the analyses in the table shows, and it is not worth as much by at least $2.00 per ton.

5508 and **4530.** Hall's Dairy Ration. The first-named sample was sent by W. H. Olcott, South Manchester. The second

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by Chas. T. Hotchkiss, West Cheshire. Cost in Cheshire, $22.00 per ton, delivered.

This claims to be made of "mill-feeds, gluten and cotton seed meal from the best of stocks and according to the analyses and tables of eminent men in the science of feeding cattle with the desired end in view of making a perfectly balanced ration."

The mixture contains about the same quantity of protein or "flesh formers" as wheat bran of average quality, twice as much fat and 7½ per cent. less of nitrogen-free extract.

The quantity of "ash" in Hall's Dairy Ration is large and more than one-quarter of it—2.37 per cent.—consists of sand and silica.

The intelligent dairyman can have but little use for ready-mixed rations of any sort. The grain and mill feed which he uses will be adjusted by him both in kind and in amount to balance the course fodder which he has on hand, and with greater economy and skill than by others whose business is selling feed and not dairying.

The dairymen's opportunities for informing himself regarding the compounding of rations are ample. His chances of detecting adulterations, or the mixtures of mill wastes of inferior value, are much better when he buys cotton seed, gluten and bran separately, each of which has a tolerably definite and constant composition, than when he buys a mixture of a number of feeds, with no such definite understanding as to its composition.

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Cost and Analyses of Feeding Stuffs.

No.	Cost per Ton.	Kind of Feed.	Analyses.					
			Water.	Ash.	Protein.	Fiber.	Nitrogen-free Extract.	Fat.
5443	------	Maize Kernel, Bloody Butcher	11.00	1.43	10.50	1.27	71.38	4.42
5442	------	" " Hearst	10.60	1.34	8.87	1.15	73.79	4.25
5441	------	" " Early Sciota	11.95	1.05	8.12	1.50	72.82	4.56
		Gluten Meals and Gluten Feeds.						
4487	$22.00	King Gluten	7.25	.70	35.19	1.33	37.10	18.43
4529	------	" "	------	------	36.25	------	------	------
5603	14.75*	Gluten Meal	8.02	1.05	40.50	2.08	41.28	7.07
5617	15.50*	Atlas Gluten Feed	5.93	1.85	37.37	11.69	28.08	15.08
5604	15.50*	Gluten Meal	6.75	.78	38.60	1.64	32.35	19.88
5605	14.90*	" "	8.12	.85	30.81	1.68	48.09	10.45
4488	------	Buffalo Gluten Feed	7.44	.79	23.25	8.11	46.99	13.42
4186	18.00	Gluten Feed	6.09	.92	17.87	9.11	54.15	11.86
		Wheat Bran.						
4505	------		8.55	5.35	18.94	8.85	53.33	4.98
4504	------		10.07	3.65	15.37	5.13	62.28	3.50
		Rice Flour.						
4496	------		7.66	10.45	9.94	17.01	47.10	7.84
5510	------		7.69	9.28	10.38	14.76	48.13	9.76
		Miscellaneous Feeds.						
5268	------	Barley Feed	9.50	3.53	12.62	8.56	61.44	4.35
4566	------	Rye Bran	------	------	14.81	------	------	------
4479	17.40	"Cattle Feed"	9.24	3.78	12.12	7.80	63.44	3.62
5508	22.00	"Hall's Dairy Ration."	9.35	8.50	18.06	7.90	45.76	10.43
4530	23.00	" " "	------	------	20.75	------	------	------

* Car lots.

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THE CHEMICAL NATURE OF DIASTASE.

Second Paper.

By Thomas B. Osborne and George F. Campbell.

In a former paper, by one of us, printed in the Eighteenth Annual Report of this Station, pp. 192–207, (also Jour. Am. Chem. Society, XVII, pp. 587–603,) the results of some attempts to isolate diastase have been detailed. This work has been continued, but as yet no preparations of diastase have been realized more active than those there described. The results given in the former paper, however, have been confirmed, and details of the process for obtaining highly active diastase have been determined more exactly.

Here follows a concise account of this later work so far as it is worth placing on record.

Fifteen kilograms of fine ground malt were treated with 30 liters of 5 per cent. sodium chloride brine, and after standing some time, with frequent stirring, the extract was pressed out and filtered, yielding 16 liters of clear filtrate. The meal residue was again treated with 15 liters of 5 per cent. brine and 15 liters more of clear extract obtained. The united solutions were then saturated with ammonium sulphate and the precipitate filtered out, dissolved in brine and filtered perfectly clear. This liquid was saturated with ammonium sulphate, the precipitate was suspended in two liters of water and dialyzed during two days. The ammonium sulphate which adhered to the precipitate, at first prevented solution of the substance, but after two days enough sulphate was removed by dialysis to allow the proteid to dissolve. The solution was filtered clear and dialyzed seven days longer. The globulin thus precipitated was filtered out and the solution, which measured 5800 c. c., was dialyzed into an equal volume of alcohol of 0.86 sp. gr. for 18 hours. The precipitate, VI,* was filtered out and the solution, which then measured 3500 c. c., was again dialyzed into an equal volume of alcohol of 0.86 sp. gr. for 18 hours, yielding precipitate VII. The filtrate from VII measured 2700 c. c. and was dialyzed into an equal volume of alcohol of 0.86 sp. gr. for 18 hours, giving precipitate VIII, the filtrate from

* The precipitates and preparations described in this paper are numbered consecutively with those specified in the former article on Diastase.

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which measured 2000 c. c. and was dialyzed into 2500 c. c. of alcohol of 0.82 sp. gr. for 18 hours. This gave precipitate IX, the filtrate from which measuring 1800 c. c. was dialyzed into twice its volume of alcohol of 0.81 sp. gr., giving precipitate X. The solution filtered from X was then treated with absolute alcohol until nothing further separated, giving precipitate XI.

These six fractions were all, separately, treated with water; X and XI dissolved completely, the others partially. The aqueous solutions, filtered clear, containing the proteoses and albumin of the six fractions, were then separately dialyzed into water, to remove all freely diffusible substances and, as no globulin was precipitated from any of them, the dialyzers were transferred to alcohol, in order to concentrate their contents, and absolute alcohol was finally added until the proteids were completely thrown down.

In this way six preparations were obtained, which, when dehydrated with absolute alcohol and dried over sulphuric acid, weighed respectively, **18,** 1.37 gm.; **19,** 1.47 gm.; **20,** 4.05 gm.; **21,** 4.82 gm.; **22,** 2.17 gm.; and **23,** 0.63 gm.

The diastatic power of these preparations was determined in the manner described in the former paper (Report of this Station for 1894, p. 194) and found to be as follows: **18**=0; **19**=60; **20**=300; **21**=300; **22,** trace; and **23**=0.

It will be noticed that nearly all the enzyme was thrown down in fractions VIII and IX, which gave preparations **20** and **21.** These were but half as active as preparation **15,** described in the former paper.

In order to purify this diastase, **20** and **21** were united, dissolved in 100 c. c. of water, the insoluble matter filtered out and washed with 35 c. c. of water (these first washings being added to the filtrate), then with more water, and finally with absolute alcohol. Dried over sulphuric acid, this preparation, **24,** weighed 0.53 gm. The filtrate and first washings from **24** were treated with 200 c. c. of alcohol of 0.885 sp. gr., making a solution containing 36.5 per cent. of alcohol. A small precipitate resulted, **25,** which when filtered out and dried over sulphuric acid, weighed 0.25 gm. and had a diastatic value of 15. The filtrate from this precipitate was mixed with 160 c. c. of alcohol of 0.84 sp. gr., raising the per cent. of alcohol to 50.7, and the precipitate, **26,** thus produced when dried as usual weighed 2.35

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gm. and had a diastatic value of 86. To the filtrate from **26** 100 c. c. of alcohol of 0.84 sp. gr. and 100 c. c. of absolute alcohol were added, raising the alcohol-content to 61.6 per cent. The precipitate, **27**, which resulted, was filtered out, weighed 2.87 gm. and had a diastatic value of 600, just twice that of **20** and **21**, from which it had been derived, and just equal to that of the most active preparation, **15**, of the former paper. To the filtrate 200 c. c. of absolute alcohol were added, giving a precipitate, **28**, which weighed 1.00 gm. and had a diastatic value of 100.

The filtrate from **28** mixed with 200 c. c. more of absolute alcohol, gave a precipitate, **29**, which weighed 0.40 gm. and showed only a trace of diastatic power. The filtrate from **29**, mixed with 400 c. c. of absolute alcohol, yielded 0.17 gm. of substance, **30**, that was totally inactive, and the filtrate from this when evaporated to dryness left a residue weighing 0.65 gm.

The results of this experiment showed that little diastase was precipitated by bringing the alcohol-content of the malt-extract to 50 per cent. by weight, while nearly all the diastase was thrown down, under the conditions described, when the proportion of alcohol in the malt-extract was made 60 per cent.

In order to still further concentrate or purify the diastase contained in precipitate **27**, this was treated with 100 c. c. of water and, without filtering from the substance which had been coagulated by precipitation and drying, 100 grams of absolute alcohol were added. The precipitate so produced was filtered out and extracted with water. The insoluble matter, after washing and drying, weighed 0.50 gm. The aqueous filtrate, from this insoluble matter, was then completely precipitated with absolute alcohol and 0.45 gm. of substance, **31**, obtained having a diastatic value of 200. The solution, filtered from the first precipitate, produced by adding an equal weight of alcohol to the solution of **27**, as just described, was mixed with enough absolute alcohol to raise this ingredient to 50 per cent. and the substance thereby thrown down, **32**, weighed when dry 1 gm. and had a diastatic value of 400. The filtrate from **32** was completely precipitated with absolute alcohol and yielded 0.2 gm. of inactive proteid. It is thus seen that the diastase instead of increasing in power under this treatment declined to two-thirds of its original activity.

Having thus learned more exactly the conditions under which diastase may be so far separated from the other malt proteids, an

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attempt was made to prepare a large quantity of material with which to carry the purification farther. Through the kindness of Mr. C. Von Eggloffstein, of the Maltine Manufacturing Company, at Yonkers, N. Y., a considerable supply of malt-extract, rich in diastase, was placed at our disposal. For this favor and much information respecting malt-extracts, we wish to express our especial thanks.

One gallon (3.785 c.c.) of this malt-extract, which had been concentrated at a low temperature *in vacuo* until it contained about 50 per cent. of solid matter, was dialyzed into water for 48 hours, whereby a large part of the sugar was removed and a thin liquid remained. This was saturated with ammonium sulphate and the precipitated proteids were filtered out, suspended in water and dialyzed for five days. To the liquid contents of the dialyzer, filtered clear from insoluble matters, alcohol was added to make 50 per cent. of the resulting mixture. This threw down a precipitate which was filtered out, dehydrated with absolute alcohol and dried over sulphuric acid.

This white, easily powdered precipitate, XII, weighed 95 grams. One-half of it was insoluble in water and salt solution. By extraction with water and precipitation with alcohol, added first to 50 per cent. and afterwards to 60 per cent., two preparations, **33** and **34**, resulted, weighing respectively 4.85 gm., and 7.21 gm., that had little diastatic power.

The solution from which the first precipitate, XII, had been separated was treated with enough alcohol to make 75 per cent., and the resulting precipitate, XIII, filtered out and found to weigh, when dried over sulphuric acid, 70 grams. This precipitate included the chief part of the diastase of this extract. It dried to a light, dusty powder of pale straw-yellow color, almost entirely soluble in water and had a diastatic value of 200.

XIII was dissolved in water and fractionally precipitated, but, for some unknown reason, the resulting fractions were almost entirely inactive.

In another attempt to make a large quantity of diastase, 3 gallons (11.4 liters) of the highly concentrated malt-extract were mixed with half their weight of water and enough alcohol to make a mixture containing 46 per cent. of alcohol. A very large precipitate, XIV, resulted, which was filtered out and as it consisted almost entirely of insoluble matter (probably globulin), it was not further examined.

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The filtrate from precipitate XIV was treated with alcohol, raising the strength to 60 per cent; the precipitate so produced was filtered out and, as it contained a large amount of sugar, it was dissolved in about five liters of water, the resulting solution was saturated with ammonium sulphate, the precipitate filtered out, suspended in one liter of water and dialyzed for five days. The precipitate in the dialyzer was filtered out and the clear solution was treated with alcohol sufficient to make 50 per cent. of the resulting mixture, but as only a little substance separated, the amount of alcohol was increased to 60 per cent. This threw down a considerable precipitate, XV, which, when dehydrated with absolute alcohol and dried over sulphuric acid, weighed 57 grams and had a diastatic value of 300.

Numerous attempts were made to obtain from portions of precipitate XV, by fractional precipitation with alcohol, diastase of greater power than 300, but without success.

Several hundred trials were made with the object to determine precisely the influence of certain conditions, such as the age of the diastase solution, and of certain substances, added in systematically varied quantities, especially sodium chloride, disodium orthophosphate, tripotassium orthophosphate, orthophosphoric acid, acetic acid and citric acid (using the amount of copper reduction as the measure of effect), but, while the results were decisive in some cases—e. g. citric acid, in the minutest quantities, always depressed or destroyed diastatic action—in the majority of instances, no such uniform results were attainable as would lead to safe conclusions in regard to the circumstances that insure a high degree of diastatic activity.

From our experience in testing these preparations it would seem that the purer the diastase is made, the more sensitive it is to external conditions, and that the method of testing the purity of the ferment by its maltose-producing power thus becomes of uncertain value and perhaps fails to furnish a safe criterion of the purity of the enzyme. That the proteid is not the only factor involved in the amylolytic action of diastase is indicated by the great influence on its activity that often accompanies the addition of various substances to its solution. In view of these facts it is not at all improbable that in thus attempting to purify diastase we remove some substance that favors, or is essential to its action, and that we may have in hand what may be properly termed

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the enzyme itself, which is feeble in its operation through the absence or deficiency of some accessory substance. Thus the addition of sodium chloride in many cases increases the diastatic action several fold. That the albumin is an essential factor in diastatic action could not be positively proved, but the results of further experience have tended to strengthen this belief. Of all the preparations that we have made, none from which albumin was absent showed amylolytic power, and those containing the most albumin were the most active. It was always possible to roughly judge of the diastatic power of a preparation, by heating a portion of its solution to 65° C. and observing the amount of coagulum formed.

The fact that active diastase was obtained only from solutions whose alcohol content lies between 50 and 60 per cent., may, we think, be regarded as probable evidence that the enzyme is not something carried down mechanically with the proteid.

JUNE, 1895.

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THE PROTEIDS OF MALT.

By Thomas B. Osborne and George F. Campbell.

As is well known, water extracts a considerable quantity of proteid matter from ground malt. This we find to consist of at least five distinct bodies, namely, a globulin, an albumin and three proteoses. Whether true peptones are present was not determined, for the malt extracts are so strongly colored that the biuret test entirely fails. Besides the proteids soluble in water another exists that may be taken up by dilute alcohol (of 0.9 sp. gr.) After extracting malt with saline solutions and alcohol, a further quantity of proteid matter remains, the nature of which we have not been able to determine.

Malt-globulin.—Ten kilograms of air dried malt, freshly prepared by ourselves in the laboratory, and ground to a fine meal were treated with twenty liters of water and, after standing three hours, were squeezed out in a press and the solution filtered clear. The residual meal was treated with eight liters more of water and the second solution was pressed out and filtered. The united solutions were saturated with ammonium sulphate, the precipitate was suspended in about four liters of water and dialyzed for three days, when it dissolved, with the exception of a slight residue. In order to reduce its volume and separate impurities, the filtered solution was again saturated with ammonium sulphate, the precipitated substance was suspended in fifteen hundred cubic centimeters of water and dialyzed until the greater part of the ammonium sulphate had been removed, when the solution was filtered clear. The matters now remaining undissolved were treated with ten per cent. salt solution to extract any soluble globulin which might have been deposited during dialysis, and the substance not taken up in salt-solution was filtered out. This last unquestionably consisted almost entirely of insoluble globulin, but as it separated from an unfiltered solution and was small in quantity it was not further examined. The salt-solution was then dialyzed free from chlorides, and the globulin thus precipitated was filtered out, washed with alcohol and dried over sulphuric acid. But 0.5 gm. of substance was obtained which,

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dried at 110°, gave 0.93 per cent. of ash and, reckoned ash-free, 15.70 per cent. of nitrogen. This was marked preparation **1.**

The solution of the ammonium sulphate precipitate, containing the bulk of the malt-proteid, from which the insoluble matter yielding preparation **1** had been filtered, was dialyzed, first, into water, until the salts were mostly removed, and then into an equal volume of alcohol of 0.84 sp. gr. for forty-eight hours. The proteid thus precipitated was filtered out and the filtrate was dialyzed into alcohol. After filtering out the second precipitate, the filtrate was dialyzed into stronger alcohol, and this process was repeated, thus depositing the proteids in four fractions, a fifth being obtained by adding absolute alcohol to the remaining solution as long as anything was thrown down. Each of these five fractions was then treated with water to dissolve albumins and proteoses and the resulting solutions were dialyzed in water for several days. The first four fractions were but partly soluble in water, and accordingly, the insoluble parts, after washing with water, were treated with ten per cent. sodium chloride solution, and the portion which in each case remained undissolved was filtered out, washed thoroughly with water and alcohol and dried at 110° for analysis. The four saline extracts were then dialyzed, but those from the third and fourth fractions were found to contain only trifling quantities of proteids. That from the second fraction gave no precipitate of globulin on dialysis, but by adding alcohol to the solution 0.49 gram of preparation **2** was obtained, having 4.33 per cent. of ash and, calculated ash-free, 15.18 per cent. of nitrogen. The sodium chloride extract from the first fraction gave a precipitate on dialysis which, after washing with water and with alcohol, weighed 1.2 grams, **3.**

The filtrate from **3,** by precipitation with alcohol, yielded **4,** weighing 1.54 grams.

After extracting the four fractional precipitates with water and with salt solution, the undissolved residue, in each case, was washed thoroughly with salt solution, with water and with alcohol and dried over sulphuric acid, giving, in the order named, preparation **5** weighing 8.0 gm., **6** weighing 5.0 gm., **7** weighing 2.87 gm. and **8** weighing 0.9 gm. These preparations, dried at 110°, had the following composition :

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MALT-GLOBULIN, BYNEDESTIN.

	3	4	5	6	7	8
Carbon	53.11	53.58	53.55	53.51	53.25	53.42
Hydrogen	6.45	6.70	7.01	6.75	....	7.15
Nitrogen	15.78	15.86 15.87	15.72	15.87	16.12	16.65
Sulphur }	24.66	23.86	1.23	1.12	1.38	} 22.78
Oxygen }			22.49	22.75		}
	100.00	100.00	100.00			100.00
Ash	0.75	1.43	1.09	0.66	0.55	0.24

Preparations **5** and **6** have the same composition as the globulin **3** and **4** obtained from the sodium chloride extracts of the fractional precipitates, while **8** contains nearly one per cent. more nitrogen, and as will be seen later, has nearly the same composition as malt albumin and is unquestionably for the most part albumin coagulated by the action of the alcohol. **7** appears to be a mixture of coagulated globulin and albumin. In a similar manner three other preparations of the coagulated globulin **9, 10** and **11** were obtained from another lot of malt.

MALT-GLOBULIN, BYNEDESTIN.

	9	10	11
Carbon	52.90	52.99	53.15
Hydrogen	6.74	6.64	6.52
Nitrogen	15.33	15.31	15.81
Sulphur	1.17	} 25.06	1.47
Oxygen	23.86	}	23.05
	100.00	100.00	100.00
Ash	0.44	0.32	0.23

Preparations **9** and **10** are lower in carbon and nitrogen than those just described, probably because, having been prepared in a smaller quantity, they carried down a larger proportion of impurities when thrown out of solution by alcohol.

From a malt extract that had been concentrated *in vacuo* at a low temperature, for which we are indebted to Mr. C. von Egloffstein, alcohol, added to make forty-six per cent. by weight of the mixture, threw down a large quantity of coagulated globulin that was not further examined, the filtrate from which, on increasing the content of alcohol to sixty per cent., gave a second precipitate that was largely soluble in water. It was accordingly mixed with water and with ammonium sulphate in excess, and the

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substance thus thrown down was suspended in a liter of water and dialyzed for five days. The insoluble residue in the dialyzer, when washed with water and alcohol, gave preparation **12**, weighing 26.78 grams. From this same extract by fractional precipitation with alcohol another small preparation of coagulated globulin, **13**, was obtained.

SUMMARY OF ANALYSES OF MALT GLOBULIN, BYNEDESTIN.

	1	2	3	4	5	6	9	10	11	12	13
Carbon			53.11	53.58	53.55	53.51	52.90	52.99	53.15	53.04	52.96
Hydrogen			6.45	6.70	7.01	6.75	6.74	6.64	6.52	6.57	6.83
Nitrogen	15.70	15.18	15.78	15.86	15.72	15.87	15.33	15.31	15.81	15.94	15.96
Sulphur					1.23	1.12	1.17		1.47		24.25
Oxygen			24.66	23.86	22.49	22.75	23.86	25.06	23.05	23.61	
			100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Although considerable differences exist among these analyses, they agree with each other as well perhaps as could be expected considering the difficulty of preparing the substance in a state of purity.

Whether other globulins occurred in the malt could not be determined by fractional precipitation owing to the small total quantity of globulin present.

The malt residue remaining after extracting with water, in the case first described, was treated with ten per cent. salt solution and the clear filtered liquid was dialyzed until free from chlorides. The precipitated globulin was filtered out, washed with water and alcohol and dried over sulphuric acid. This preparation, **14**, weighed 4.12 grams and had the following composition :

MALT-GLOBULIN, BYNEDESTIN.

	14		
	I.	II.	Average.
Carbon	52.94	52.78	52.86
Hydrogen	6.87	6.79	6.83
Nitrogen	16.16	16.18	16.17
Sulphur	1.14		1.14
Oxygen			23.00
			100.00
Ash	0.96		

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It is to be noted that the carbon is a little lower and the nitrogen higher than the average of the figures previously obtained. This is perhaps due to presence of a little edestin,* the globulin of ungerminated barley. Edestin is not readily soluble in dilute saline solutions, such as are formed on treating seeds with water, and, if occurring in the malt, ought to be present in the salt extract of the meal after it has been exhausted with water. Owing to the incomplete extraction with water, the preparation obtained in this case should be a mixture of the two globulins, if both are present. Edestin can only occur in extremely small quantity in malt, since but 4.12 grams of globulin were obtained by extracting ten kilograms of malt with salt solution after treatment with water, and most of this consisted of the more soluble globulin first described. It is interesting to note the practically complete disappearance of edestin during germination and the formation of the more soluble globulin with three per cent. less nitrogen and two per cent. more carbon. It is, of course, not demonstrated that the malt globulin is derived from edestin, but that the proteids undergo extensive changes before conversion into proteoses and peptones is very evident.

When dissolved in considerable quantity in salt solution, bynedestin is precipitated by water, is not precipitated by saturation with sodium chloride, and but partly by saturation with magnesium sulphate. With the biuret test it gives a violet color. Dissolved in ten per cent. sodium chloride solution and heated to 65°, a turbidity is produced which increases to flocks at 84°. The coagulum gradually augments as the temperature rises but, after heating to 100°, the filtrate from the coagulum yields an abundant precipitate on adding dilute hydrochloric acid. The solution in ten per cent. sodium chloride brine gives a precipitate with acetic acid which is soluble in an excess of the acid. These reactions show that this body is in no sense a proteose, but has characters common to plant globulins. Bynedestin formed about sixty per cent. of the total water-soluble proteid matter in the malt extract first described in this paper. Out of a total of 33.27 gm. of proteid recovered in the different preparations from 100.00 gm. of malt, 19.88 gm. consisted of bynedestin.

* Annual Report of this Station for 1894, p. 172, and Journal of American Chemical Society, vol. 17, p. 545.

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Malt Albumin, Leucosin.—Under the name Leucosin, one of us has described an albumin occurring in small quantity in the seeds of wheat, rye and barley. In the aqueous malt-extracts an albumin is found identical with leucosin in properties and composition. As stated in previous papers, this albumin is so intimately associated with diastatic action as to make probable that it is either diastase itself or an essential factor in diastatic amylolysis. In attempts to fractionally separate malt-leucosin from the associated proteids, many preparations have been made which are mixtures of leucosin with proteose. In several cases these mixtures have been analyzed and have so nearly the composition of leucosin as to make certain that one of the proteoses of malt has very nearly the same ultimate composition as the albumin. Analyses of these mixtures may therefore be taken to represent the composition of either of these proteids.

In the extraction first described in this paper, two preparations, **15** and **16**, of albumin coagulated by alcohol, were obtained from solutions out of which the globulin had been precipitated by alcohol. If, as is invariably assumed, proteose cannot be rendered insoluble by contact with alcohol, these preparations may be taken to represent the composition of malt albumin. Their composition is here compared with that of leucosin coagulated by heat.

LEUCOSIN.

	Malt.		Wheat, Rye and Barley. Average.
	15	16	
Carbon	53.23	52.90	52.93
Hydrogen	6.64	6.79	6.80
Nitrogen	17.00	16.41	16.70
Sulphur	}		1.37
Oxygen	} 23.13	23.90	22.20
	100.00	100.00	100.00
Ash	0.84	0.55	

The following figures give the composition of preparations derived from three different samples of malt. These were all obtained by precipitating the proteids with ammonium sulphate, dissolving the precipitates in water, dialyzing away the greater part of the salt and fractionally precipitating the solutions with alcohol. The fractions were dissolved in water as far as possible,

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filtered from the undissolved globulin and the aqueous solutions dialyzed for several days in water and then in alcohol. The proteids thus precipitated were mixtures of proteose and albumin. It will be noted that they all agree fairly well with one another and with leucosin in composition. Since these mixtures contained from six and a half to fifty per cent. of albumin, it is evident that the two proteids have a very similar composition.

MALT LEUCOSIN AND PROTEOSE.

	17	18	19	20	21	22	23	24
Carbon.....	53.16	53.19	52.80	52.50	52.38	52.85	52.61	52.55
Hydrogen ...	7.03	6.71	6.96	6.72	6.63	6.67		
Nitrogen	16.50	16.60	16.09	16.10	16.51	16.25	16.35	16.41
Sulphur...		1.38	1.45					
Oxygen ...	23.31	22.12	22.70	24.68	24.48	24.23		
	100.00	100.00	100.00	100.00	100.00	100.00		
Ash.....	0.84	0.78	0.59	0.66	1.55	0.22	0.51	

The preparations containing the most albumin, when dissolved in water, became turbid on heating to 50° and formed flocculent coagula at 58°. By saturating their solutions with magnesium sulphate the albumin was completely thrown out, and together with it much of the proteose. Saturating solutions of these preparations with sodium chloride, gave no precipitate when they contained but little albumin, but a heavy precipitate appeared on adding acetic acid to the salt-saturated solution. Solutions of the preparations containing much albumin gave precipitates on saturating with sodium chloride.

PROTEOSES OF MALT.

The proteose associated with albumin has the properties of a *protoproteose*, since it is readily and abundantly precipitated from its salt-saturated solution on adding acetic acid.

When malt extract is fractionally precipitated with alcohol a considerable quantity of proteose is thrown down before the albumin, so that the water-soluble part of the first fraction is chiefly proteose. The proportion of albumin in the precipitates increases as the alcohol is made stronger up to the point where it is all precipitated. At this stage much proteose remains dissolved which behaves differently from that first thrown down. A large quantity of concentrated malt extract was precipitated by alcohol added to 60 per cent., and after filtering, the proportion of alcohol was raised to 72 per cent. The substance thereby precipitated, when

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dried over sulphuric acid, weighed 38 grams. This was dissolved in water, the solution was heated to boiling, the coagulated albumin was filtered out and 20 per cent. of sodium chloride added to the solution. This caused a slight precipitate which was evidently the alcohol-soluble proteid, to be described later. The filtrate from this substance was then treated with a little acetic acid, which produced a copious precipitate that was filtered out and dissolved in water. This solution, exactly neutralized with sodium carbonate and fully saturated with salt, yielded a considerable precipitate, which was filtered out, dissolved in water and dialyzed free from chlorides.

A very small deposit, consisting of minute spheroids, was found in the dialyzer. This dissolved readily in exceedingly dilute salt solution, from which it was thrown down by much water. On adding nitric acid to the solution of this substance a precipitate was produced that dissolved on warming and reappeared on cooling, gave a clear pink biuret reaction and was precipitated by copper sulphate. On boiling its solution not even a turbidity was produced. Except for its behavior on heating, this substance has all the reactions of a *heteroproteose*. The amount obtained was exceedingly small, only enough for the above reactions. The solution filtered from this heteroproteose was concentrated by gently boiling over a low flame.

During concentration of the solution filtered from the heteroproteose a coagulum developed as a film on the surface of the liquid and sides of the dish. We have frequently noticed that plant proteoses from various seeds coagulate in this manner although behaving in most other respects like typical proteose. This coagulum, **25**, filtered out, washed with water and alcohol and dried over sulphuric acid, weighed 0.29 gm. and contained 16.84 per cent. of nitrogen.

The filtrate from **25** was precipitated by alcohol and gave 1.45 gm. of **26**, having the following composition, when dried, at 110° :

MALT PROTEOSE, **26**.

	I.	II.	Average.
Carbon	50.61	50.64	50.63
Hydrogen	6.72	6.61	6.67
Nitrogen	16.69		16.69
Sulphur, Oxygen			26.01
			100.00
Ash			1.29

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As will be remembered, in making these preparations, **25** and **26**, the proteose was precipitated, first, by adding acetic acid to the solution containing 20 per cent. of salt and, second, by dissolving the precipitate thus produced in water and saturating the neutralized solution with salt. The filtrate, **A**, from the first, as well as the filtrate, **B**, from the second precipitation, still contained proteose.

A was therefore neutralized with sodium carbonate and saturated with salt, but, as no precipitate resulted, acetic acid was added as long as any proteid was thrown down.

B was treated similarly with acetic acid and the two precipitates thus obtained from the salt-saturated solutions were collected on the same paper and the filtrates were united and marked **C**. The precipitates were dissolved in water, the solution carefully neutralized, dialyzed free from chlorides and then concentrated by slow boiling. During concentration a small coagulum separated which was filtered out, washed with water and alcohol and dried over sulphuric acid. This preparation, **27**, weighed 0.22 gm. and contained, without correcting for ash, 16.40 per cent. of nitrogen.

An excess of alcohol was added to the filtrate from **27**, and the precipitate produced, after treating in the usual manner, gave 1.49 gm. of preparation **28**, which, dried at 110°, had the following composition:

MALT PROTEOSE, 28.

	I.	II.	Average.
Carbon	49.82	49.87	49.85
Hydrogen	6.69	6.64	6.67
Nitrogen	16.00		16.00
Sulphur, Oxygen			27.48
			100.00
Ash			1.54

The salt-saturated filtrate, **C**, from which **27** and **28** had been precipitated, was neutralized and dialyzed until much of the salt had been removed, then concentrated and dialyzed until free from chloride. The solution was finally concentrated to small volume and precipitated with alcohol. The substance so obtained, after treating as usual, weighed 6.25 gm., but was found to contain 4.70 per cent. of ash and only 8.91 per cent. of

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nitrogen, reckoned ash-free. This precipitate, which was expected to contain *deuteroproteose*, evidently included much non-proteid matter.

It will be noticed that of the 38 grams of substance taken, only a very small part was recovered. It is probable that a large share of the substance (p. 246) was non-proteid, and also that during the dialysis much proteose was lost by diffusion.

Preparation **26** has the properties of a proto-proteose and may be regarded as such. Preparation **28** is a mixture of proto- and deuteroproteose. Pure deuteroproteose was not obtained, it having been impossible to separate the non-proteid substances associated with it.

It thus appears that at least two protoproteoses exist in malt, for **26** has much less carbon than the mixtures of proteose and albumin **17** to **24**. Preparation **17** contains about 95 per cent. of proteose and has 53.16 per cent. of carbon, whereas **26** has only 50.63 per cent. of carbon. This difference can scarcely be due to non-proteid impurities, for **26** contains even more nitrogen than **17**. According to the definitions now accepted, a protoproteose is any form of proteid which is soluble in pure water, uncoagulable by heat, precipitable by saturation with sodium chloride, and gives a pink biuret reaction and a precipitate with nitric acid that dissolves on warming and reappears on cooling. The protoproteoses obtained by artificial digestion, usually have a composition varying with that of the proteids from which they are derived, and the proteoses of malt may also be expected to differ according as they originate from one or another of the several proteids of barley. While the plant proteoses resemble the digestive proteoses in the reactions just specified, some of their physical properties are so different that it is not improbable that they are quite distinct substances.

Malt Proteid soluble in dilute Alcohol. Bynin.

Three kilograms of ground malt were extracted with alcohol of 0.90 sp. gr. The extract was filtered clear, and concentrated to about one-third its original volume, on a water bath. When cool, the solution was poured off from the separated proteid and the latter was washed with dilute salt solution, with water, with ether to remove adhering water, and finally, with absolute alcohol. Dried over sulphuric acid, this preparation, **29**, weighed 33.1 gm., being 1.11 per cent. of the malt.

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Dried at 110° it had the following composition:

BYNIN, 29.

	I.	II.	Average.
Carbon	55.01	54.93	54.97
Hydrogen	6.77	6.49	6.63
Nitrogen	15.98	16.13	16.06
Sulphur	0.94		0.94
Oxygen			21.40
			100.00
Ash			0.67

In order to fraction this substance, 27 grams were dissolved in alcohol of 0.90 sp. gr., the solution filtered perfectly clear, concentrated to small volume and poured into absolute alcohol, a few drops of ten per cent. salt solution being added to cause the proteid to separate. The precipitate so produced was filtered out, treated with absolute alcohol and dried over sulphuric acid. This preparation, **30**, weighed 20 gm., and when dried at 110° had the following composition:

BYNIN, 30.

	I.	II.	Average.
Carbon	54.74	55.08	54.91
Hydrogen	6.61	6.62	6.62
Nitrogen	16.21	16.06	16.14
Sulphur	0.83		0.83
Oxygen			55.07
			100.00
Ash			0.40

Of preparation **30**, 16 grams were dissolved in 180 c.c. of warm alcohol of 50 per cent. by volume, and a part of the proteid precipitated by cooling to 0° C. The solution was decanted and the precipitate, **30*a***, was treated as just described for **30**. The substance now separated, **30*b***, was treated in the same manner. **30*c***, thus obtained, was dissolved in a little strong alcohol and the perfectly clear solution poured into absolute alcohol, adding also a few drops of ten per cent. salt solution. The precipitate was then dehydrated with absolute alcohol and dried over sulphuric acid. This preparation, **31**, weighed 8.3 grams and gave the following results on analysis:

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BYNIN, 31.

	I.	II.	Average.
Carbon	55.07		55.07
Hydrogen	6.75		6.75
Nitrogen	16.18	16.42	16.30
Sulphur	0.84		0.84
Oxygen			21.04
			100.00
Ash			0.10

The solutions, containing 50 per cent. of alcohol, which had been decanted from 30*a*, 30*b* and 30*c*, were united, concentrated to small volume, cooled and the liquid poured off from deposited substance. The latter, dehydrated with absolute alcohol and dried over sulphuric acid—preparation 32—weighed 5.0 grams.

As seen from the following table, these analyses show that the proteid has not been separated into fractions of differing composition.

SUMMARY OF ANALYSES OF BYNIN.

	29.	30.	31.	32.	Average.
Carbon	54.97	54.91	55.07	55.16	55.03
Hydrogen	6.63	6.62	6.75	6.67	6.67
Nitrogen	16.06	16.14	16.30	16.53	16.26
Sulphur	0.94	0.83	0.84	0.76	0.84
Oxygen	21.40	21.50	21.04	20.88	21.20
	100.00	100.00	100.00	100.00	100.00
Ash	0.67	0.40	0.10	0.16	

These figures are, except for hydrogen, in remarkably close agreement with those given by Chittenden and Osborne for the composition of zein, the alcohol-soluble proteid of maize; but in properties the two bodies are very distinctly different. Compared with hordein, the alcohol-soluble proteid of barley, this malt-proteid contains about one per cent. more carbon and one per cent. less nitrogen.

ALCOHOL-SOLUBLE PROTEIDS.

	Hordein, of Barley.	Bynin, of Barley-Malt.	Zein, of Maize.
Carbon	54.29	55.00	55.23
Hydrogen	6.80	6.67	7.26
Nitrogen	17.21	16.26	16.13
Sulphur	0.83	0.84	0.60
Oxygen	20.87	21.20	20.78
	100.00	100.00	100.00

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Malt Proteid Insoluble in Water, Salt Solution and dilute Alcohol.

The proteid remaining undissolved, after extracting malt with water, salt solution and alcohol, was not separated or identified, but its presence in considerable quantity was shown, as follows:

After extracting 100 grams of malt, first, with ten per cent. sodium chloride solution and then, with alcohol of 0.90 sp. gr., dehydrating with absolute alcohol and drying in the air, a residue was obtained which weighed 75 grams and contained 0.82 per cent. of nitrogen, equivalent to 0.62 per cent. reckoned on the original malt. Assuming, as is probably true, that this nitrogen belongs to proteid matter, we have in the residue, 3.8 per cent. of proteid, insoluble in the reagents named.

Summary.

In the malt used in this investigation we have found:

1. *Bynedestin*,* readily soluble in very dilute salt solution, therefore largely passing into the aqueous extracts because of the soluble salts of the seed. This globulin contains two per cent. more carbon and three per cent. less nitrogen than edestin, the globulin of barley, and is much more soluble in very dilute salt solutions than edestin.

The composition of this globulin, as shown by the average of eleven analyses, is:

Bynedestin.

Carbon	53.19
Hydrogen	6.69
Nitrogen	15.68
Sulphur	1.25
Oxygen	23.19
	100.00

Bynedestin, dissolved in ten per cent. sodium chloride solution, gives a turbidity at 65° and a flocculent coagulum at 84°, but, even after heating for some time at 100°, the coagulation is far from complete.

This proteid is not precipitated by saturating its solutions with sodium chloride, and but partly precipitated by saturating with magnesium sulphate.

* From *βυνη*, malt and *εδεστὸς*, edible.

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2. *Leucosin*, an albumin, identical in composition and properties with the leucosin found in wheat, rye and barley. The composition of this proteid was found to be:

MALT-ALBUMIN, LEUCOSIN.

Carbon	53.07
Hydrogen	6.72
Nitrogen	16.71
Sulphur, Oxygen	23.50
	100.00

Leucosin is intimately associated with diastase*. Heated to 50°, solutions of this proteid become turbid, and at 58° a flocculent coagulum occurs. Coagulation, however, is incomplete unless the solution is heated for some time and the temperature raised to about 70°. Saturation with sodium chloride or with magnesium sulphate partly precipitates leucosin.

3. A *Protoproteose* readily precipitated from aqueous solution by adding an equal weight of alcohol. No preparations of this body were obtained free from albumin. Its composition is nearly the same as that of leucosin, since preparations containing from 90 to 50 per cent. of it, together with from 10 to 50 per cent. of leucosin, are not distinguishable by analysis.

4. A *Protoproteose* less readily precipitated by alcohol than the preceding, and of a different composition as shown by the following figures:

MALT-PROTOPROTEOSE.

Carbon	50.63
Hydrogen	6.67
Nitrogen	16.69
Sulphur, Oxygen	26.01
	100.00

That this is not an impure preparation of the preceding, is indicated by the fact that the amount of nitrogen is alike in both, while the carbon differs by two per cent. This difference would probably not be caused by non-proteid impurities. It is possible

* See papers on Diastase, Annual Reports of this Station, 1894 pp. 202, 204 and 1895, p. 238.

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that the deuteroproteose, next to be described, may not have been completely separated by the process employed.

5. A *Deuteroproteose* which could not be separated from non-proteid impurities.

6. A *Heteroproteose* in extremely small amount.

7. *Bynin* a proteid insoluble in water and saline solutions, but readily soluble in dilute alcohol. About 1.25 per cent. of this proteid was obtained from the malt, having the following composition:

BYNIN.

Carbon	55.03
Hydrogen	6.67
Nitrogen	16.26
Sulphur	0.84
Oxygen	21.20
	100.00

8. A proteid insoluble in water, in salt solution and in alcohol, amounting to 3.80 per cent. The composition and properties of this proteid we have been unable to determine.

PROPORTIONS OF THE VARIOUS PROTEIDS IN MALT.

Assuming 21 per cent. of the total nitrogen of the malt to exist in non-proteid bodies, and admitting the malt proteids to contain on the average 16.3 per cent. of nitrogen, we have, in the malt investigated, a total of 7.84 per cent. of proteids.

As already indicated, p. 251, proteid equal to 3.8 per cent. of the malt was insoluble in alcohol and in salt solution.

It was shown on page 248 that 1.11 per cent. of proteid was recovered from alcohol solution, and making allowance for loss, we may place the amount of alcohol soluble proteid at 1.25 per cent.

Subtracting the sum of the insoluble proteid and the alcohol soluble proteid from the total malt proteids, we have 2.79 per cent. for proteids soluble in salt solution, viz: globulin, albumin, and proteoses.

The amount of coagulable proteids was found to be 1.50 per cent., consisting of albumin and a part of the globulin. There remains then 1.29 per cent. for the uncoagulated globulin and the various proteoses. We have accordingly, in the malt used for these determinations, approximately:

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		Per cent.
Proteid, insoluble in salt solution and in alcohol		3.80
Bynin, soluble in dilute alcohol		1.25
Bynedestin, leucosin and proteoses soluble in water and salt solution	Coagulable	1.50
	Uncoagulable	1.29
Total proteids		7.84

The results of this study show: that, in germination, the proteids of barley undergo extensive changes without acquiring, or before acquiring the properties of proteoses; that hordein disappears and an alcohol soluble proteid of entirely different composition takes its place; that edestin also disappears and a new globulin is formed very different both in composition and properties. The albumin, on the other hand, appears to be unchanged in its characters, but its quantity is increased. It is to be noted also that hordein and edestin are both replaced by proteids much richer in carbon and poorer in nitrogen.

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THE PROTEIDS OF THE POTATO.

By Thomas B. Osborne and George F. Campbell.

So far as we can ascertain, the only investigations of the proteids obtained from the tubers of the potato have been made by Rüling (Liebig's Annalen LVIII, 306), Ritthausen (Pflüger's Archiv XXI, 101), Zöller (Ber. d. Deutsch. Chem. Ges. XIII, 1064), and Vines (Journal of Physiology, vol. 3, p. 93).

Rüling contributes a partial analysis of the coagulum obtained by boiling the juice of the potato.

Ritthausen states that nearly the whole of the proteid of the potato is contained in the juice. He obtained two preparations from the juice by heating to 65° C., filtering off the coagulum and heating the filtrate to 76°. The two coagula were analyzed with results as stated beyond. He says "these results do not contradict the assumption that the potato contains albumin, yet the content in sulphur is only one-half as great as in albumin of serum egg and muscle.

Zöller extracted the pressed and washed potato pulp with ten per cent. sodium chloride brine and obtained a globulin, precipitable by saturating its solution with sodium chloride and when dissolved in ten per cent. sodium chloride brine coagulating on heating to 59° or 60°. From his results he concludes that the potato contains a globulin resembling myosin.

On investigating the juice of the potato Zöller obtained results which led him to conclude that the proteids therein dissolved are also globulins, but that further study was needed to explain their "peculiar deportment," especially, it is to be inferred, the fact of coagulation occurring at from 43° to 48°, and again, at 62°.

Vines states that prolonged treatment of the "crystalloids" of the potato with ten per cent. sodium chloride solution produces an apparent effect, but that they dissolve readily in a saturated solution of this salt, thus differing from all other protein crystals which he had observed.

Having had occasion to prepare a quantity of pure starch from the potato, we took advantage of the opportunity to examine the associated proteids.

After removing the skins, the tubers were crushed and squeezed in a drug press. The juice was strained through cloth and allowed to stand and deposit the greater part of the sus-

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pended matters. It was then saturated with ammonium sulphate and the precipitate so produced was filtered out. The potato pulp was washed with water and the washings after clearing were also saturated with ammonium sulphate. The two precipitates thus obtained were united, dissolved in salt solution, filtered clear and dialyzed.

The washed pulp was then treated with ten per cent. sodium chloride solution; the proteid, thus extracted, was precipitated with ammonium sulphate, dissolved in salt solution, filtered clear and also dialyzed. The globulin precipitated very slowly on dialysis, and after fourteen days was filtered out. The proteid obtained from the juice was much greater in amount than that from the salt extract of the pulp. The globulin, from both juice and salt extract, was then dissolved in salt solution, the solutions were united, filtered from a considerable quantity of insoluble globulin (rendered insoluble by long contact with water,) and the solution again dialyzed. After freeing from chlorides, the contents of the dialyzer were filtered, the reprecipitated globulin was washed with water and alcohol and dried over sulphuric acid, giving preparation **1**, weighing 7.34 grams.

The filtrate, from preparation **1**, still contained proteid and was therefore saturated with sodium chloride, which completely precipitated the remaining globulin. This was then dissolved in dilute salt solution and dialyzed in water until free from chlorides and, as the proteid was not thus precipitated, the dialyzer was transferred to alcohol, which soon threw down all the proteid. This was filtered out, washed in water and absolute alcohol and dried, giving 0.5 of a gram of preparation **2**.

The solutions, filtered from the globulin precipitated by the dialysis first described, were united and, in order to obtain the proteid in a solution of smaller volume, the liquid was saturated with ammonium sulphate, the precipitate produced was dissolved in a little water and the clear solution dialyzed, first in river water and then in distilled water. The globulin so precipitated was filtered out, washed with water and absolute alcohol and dried, yielding preparation **3**, weighing 3.40 grams. The filtrate from this preparation was dialyzed into alcohol and the resulting precipitate filtered out, washed with absolute alcohol and dried, forming preparation **4**, which weighed 1.74 grams.

The filtrate from **4** was further dialyzed in alcohol and the proteid completely precipitated by adding absolute alcohol. This

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substance after filtering out, washing with absolute alcohol and drying, weighed 0.53 of a gram and formed preparation 5.

These several preparations were analyzed, after drying them at 110°, with the following results :

POTATO GLOBULIN. TUBERIN.

	Osborn and Campbell					Ritthausen.	
	1	2	3	4	5	I	II
Carbon	53.62	....	53.58	53.64	....	....	53.87
Hydrogen	6.80	....	6.91	6.83	....	....	7.30
Nitrogen	16.15	16.29	16.36	16.34	16.07	15.76	15.98
Sulphur	1.22	....	1.27	23.19	....	....	0.86
Oxygen	22.21	....	21.88				21.99
	100.00		100.00	100.00			100.00

The close agreement in composition among our five fractions is in itself, strong evidence that, besides this globulin, but little proteid is present in the potato. These five fractions practically include the whole of the proteid matter dissolved in the juice and salt extracts. The above figures given by Ritthausen for the composition of the proteid, obtained by coagulation of the juice at 65° and 76°, are also in close agreement with ours, excepting those for sulphur. The slightly lower nitrogen content of the coagulated globulin is to be expected, since proteids generally, if not always, yield some ammonia when coagulated by heat.

The potato globulin, when heated slowly in a double water bath, shows a wide range of variation in its coagulation point depending on the conditions under which it is dissolved.

A solution of this globulin prepared by treating a portion of preparation 1 with 10 per cent. sodium chloride solution and filtering out the insoluble matter, became turbid at 56° and a flocculent coagulum separated at 64°. After heating some time at 70° the coagulum was filtered out and the filtrate, when again tested, gave a turbidity at 72° and a flocculent coagulum at 76°.

Another preparation of this globulin was extracted, in the same way, with 10 per cent. salt solution, and the dissolved proteid was filtered from the insoluble matter and precipitated by saturating the solution with sodium chloride. The precipitated globulin was washed with saturated salt solution and removed from the paper mixed with a considerable quantity of the concentrated brine. Distilled water was gradually added until all of the proteid dissolved. The resulting solution was therefore

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almost completely saturated with the proteid. This solution when slowly heated in the double water bath to 44° C. and held at this temperature some minutes, became turbid and after a time flocculent, although the temperature remained perfectly constant. After raising the temperature to 50° it was filtered from the small coagulum which had formed and again heated, turbidity occurring at 50¼° and flocks separating at 51°. After heating some time at 56° the solution was filtered from the second small coagulum and again tested. Turbidity occurred at 58° and flocks separated at 59°, gradually increasing to a large coagulum at 66° which was filtered out. The filtrate now became turbid at 63°, flocks forming at 66°, and increasing to a considerable coagulum at 70°. The temperature was raised to 80° and the coagulum, which was about the same in amount as that formed at 66°, was filtered out. The filtrate gave only a trace of coagulum on boiling. The two coagula first formed were very small compared with the last two.

This test was then repeated with the same solution diluted with an equal volume of water. This solution was heated for some time at 44°, but remained perfectly clear. The temperature was then very slowly increased and at 53° a turbidity formed which, however, was scarcely greater at 56°. Above this temperature the turbidity increased until flocks separated at 62°, and a large coagulum formed at 65°. The solution filtered at 66°, gave a turbidity at 66°, with flocks at 68°, which formed a large coagulum on gradually raising the temperature to 80°, the filtrate from which gave no more coagulum on boiling.

The test was again repeated by mixing four parts of the same solution with one of water, and the same results obtained as with the solution diluted with an equal volume of water. This shows that within wide limits the temperature of coagulation does not depend on the relative quantity of dissolved proteid, but that the very low coagulation point of the undiluted solution was probably due to the presence of nearly enough sodium chloride to cause precipitation of the globulin. It will be noticed that coagulation of the proteid, which began at 56°, was not completed until the temperature had reached about 80°. This does not necessarily show the presence of several proteids, for such gradual coagulation is characteristic of most plant globulins, many being only very slowly coagulated, even by long boiling (Chittenden & Mendel, Jour. Phys. XVII, p. 52). The coagulum separated

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by heating solutions of this globulin to 75° C. is very soluble, on gently warming, in extremely dilute hydrochloric acid, even acid of $\frac{1}{100}$ per cent. dissolving the substance readily at 40°–50° C. The coagulum dissolves quickly and completely in $\frac{1}{10}$ per cent. caustic potash solution at 20° and in one per cent. sodium carbonate solution at 70° C. These solutions are precipitated by neutralization, but the substance thrown down is not soluble in salt solutions. The low heat-coagulation point obtained for the solution of the globulin precipitated with salt and dissolved in a minimum quantity of water is in accord with that given by Zöller for the proteid similarly obtained by him from the juice of the potato, and our observations explain to some extent the questions which he considered to require further investigation.

In order to determine more definitely whether other proteids were present with the globulin, a larger quantity of filtered potato juice, obtained from potatoes which had been washed carefully, but from which the skins had not been removed, was saturated with ammonium sulphate, the precipitate was dissolved in dilute salt solution, which was then filtered and saturated with sodium chloride. The globulin thus precipitated was filtered out, the filtrate was dialyzed for twenty-four hours in order to remove a considerable part of the salt, and was then saturated with ammonium sulphate. The small quantity of proteid thus precipitated was filtered out, dissolved in a little dilute salt solution and sodium chloride added to complete saturation. A considerable part of the dissolved proteid was thereby precipitated, which was filtered out and dissolved in dilute salt solution. The resulting liquid became turbid on heating to 58° C. and flocculent at 60°. The substance was evidently a part of the globulin which had escaped precipitation on the first saturation with salt, probably owing to the presence of some constituent of the juice.

The solution filtered from the salt saturation precipitate *last* described, was diluted with two volumes of water and then saturated with ammonium sulphate. The proteid thus separated was filtered out, dissolved in water and found to yield a turbidity at 52° and a flocculent coagulum at 58°, a coagulation point not essentially differing from that of the globulin.

The whole solution was then heated for some time at 70° C. in a water bath, the coagulum which separated was filtered out, and the filtrate, after removing a small quantity of coagulum, which separated on heating to 75°, was boiled and found to

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remain clear. This solution was then saturated with ammonium sulphate and the very small precipitate produced was filtered out, dissolved in a small amount of water and tested with the following results: nitric acid added to the solution in the cold gave no precipitate; saturation with sodium chloride gave no precipitate even when acetic acid was added. The biuret test was without result owing to the strong brown color of the solution. This substance therefore failed to give the most characteristic reactions of the proteoses, yet it must be considered as a proteose since in its essential properties it agrees more closely with this class of proteids than with any other.

The experiments made by Zöller on the juice of the potato were repeated by us with the same results as described by him, except that we found the solution of the precipitate produced by saturation with salt, to yield a flocculent coagulum at 52°, while Zöller's solution coagulated at 46°–48°. It has already been shown that a solution of the globulin similarly prepared gave a coagulum at 44°, and on dilution with one volume, as well as with one-fourth volume of water, the same solution coagulated at 62°. It is thus evident that the temperature of coagulation is not to be depended upon as a means of identifying this proteid with certainty. The other reactions described by Zöller are those given by the potato globulin. From these results then it would appear that by saturating the juice of the potato with sodium chloride the greater part of the globulin is precipitated, but that a not inconsiderable part remains in solution. If this is separated by saturation with ammonium sulphate and the precipitate so produced is dissolved in water, a large part of this globulin can be precipitated by again saturating with salt. The proteid still remaining in solution is nearly all coagulable and the solution on heating behaves exactly like a solution of the globulin.

Conclusion.

The proteids of the potato tuber consist of a globulin, for which we propose the name *Tuberin*, and a proteose, the latter occurring in very small amount. The properties of tuberin were found to be as follows:

It is precipitated by saturating its solutions with sodium chloride, sodium sulphate, magnesium sulphate, or ammonium sulphate. By acetic acid or nitric acid a precipitate is given readily soluble in an excess of acid even in the presence of salts.

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Potassium ferrocyanide gives no precipitate until acetic acid is added. Mercuric chloride gives no precipitate, but picric acid or tannic acid throw down the globulin. With the biuret, Millon's, and the xanthoproteic tests the usual reactions are given.

Tuberin is soluble in very dilute saline solutions and therefore the juice of the potato contains the greater part of this proteid. By dialysis it is precipitated slowly and incompletely because of the difficulty of removing *all* soluble salts by this process. Like other easily soluble globulins it readily changes to the insoluble modification, so that preparations made by dialysis are to a great extent insoluble in saline solutions. In contact with alcohol it very quickly loses its solubility.

When dissolved in ten per cent. sodium chloride solution tuberin shows a somewhat variable heat-coagulation point depending on the conditions under which it is tested. In general a flocculent coagulum is formed on heating to 60°–65° C. Coagulation is, however, not complete until the solutions have been heated for some time at 80° C. The composition of this globulin was found from an average of several accordant analyses to be :

TUBERIN.

Carbon	53.61
Hydrogen	6.85
Nitrogen	16-24
Sulphur	1.25
Oxygen	22.05
	100.00

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LEGUMIN AND OTHER PROTEIDS OF THE PEA AND THE VETCH.

By Thomas B. Osborne and George F. Campbell.

Legumin.

Under the name Legumin, many preparations, obtained from various seeds, have been described, but in such different and often conflicting terms as to leave us completely in doubt with regard to the nature of this substance.

This confusion appears to have arisen largely through the mistaken idea, which formerly was very generally held, that all the proteids extracted from seeds by water and precipitated by acids are one and the same substance.

The methods of analysis employed by the earlier chemists were too crude or uncertain to set forth the slight differences in composition of the various plant proteids, and the difficulty of making pure preparations tended, as the subject was further studied, to add to the confusion. Since the methods of analysis have been perfected and the more recently developed modes of studying proteids introduced, legumin has received little or no attention. In recent literature legumin is most commonly referred to as a substance extracted from seeds by caustic alkalies, and more or less altered by the action of the solvent, but nothing has been done, to our knowledge, to show the nature of the original proteid.

The object of our investigation has been to examine the seeds in which legumin is said to exist and to determine as definitely as possible the composition and character of this substance.

In 1806 Einhof (Gehlens Jour. d. Chem. 6, 543) recognized a proteid in beans and lentils which he considered to be different from the bodies of this class previously known.

Braconnot (Ann. de Chim. et de Phys., 34, (2), 68, 1827) named this substance legumin.

Noad (Chem. Gaz., 1847, p. 357) prepared and analyzed legumin from peas and beans.

Norton (Amer. Jour. Sc. (2), 5, 22, 1847) prepared legumin from peas, sweet almonds and oats, and gave analyses of his preparations.

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Loewenberg (Pogg. Ann., 78, 327) considered that legumin, as previously prepared, contained albumin and devised a method for the separation of these two proteids and gave analyses of the substances so prepared from almonds and peas.

Liebig (Ann. d. Chem. u. Pharm., 39, 138) obtained plant casein (legumin) from beans, lentils and peas and gave an account of the properties of this proteid and two analyses. He concluded that the substance was identical in properties and composition with milk casein.

Dumas and Cahours (Jour. f. Prakt. Chem., 28, 398) prepared legumin from peas, lentils, beans, almonds, plums, filberts and white mustard. They considered all these seeds to contain the same proteid substance; that obtained from the three first named seeds being less pure than that from the others and therefore, containing somewhat less nitrogen.

They gave analyses of preparations from all these seeds and an extended account of the properties of legumin, based on a study of the preparation obtained from the almond.

Contrary to Liebig, they concluded that this substance is not identical either with milk casein or plant casein. The latter designation they applied to the body which separates out on cooling a concentrated hot alcoholic extract of wheat gluten.

Rochleder (Ann. d. Chem. u. Pharm., 46, 155) pointed out that the substance obtained from beans, lentils and peas by Liebig was different from that of the almond described by Dumas and Cahours, and that for this reason these investigators did not reach the same conclusions. Rochleder prepared and analyzed legumin from two varieties of beans.

In 1868 Ritthausen undertook a study of legumin, the results of which are recorded in a series of papers whose publication extended over a period of fifteen years.*

He recognized that the seeds of almonds, plums, filberts and white mustard, which had been previously stated to yield legumin, really contain a different proteid, which he called

* Jour. f. Prakt. Chem., 103, 65, 1868.
Die Eiweisskörper, etc., Bonn., 1872.
Pflügers, Archiv, 15, 269, 1877.
Ibid., 16, 293, 1878.
Ibid., 18, 236, 1878.
Jour. f. Prakt. Chem. (2), 24, 221, 1881.
Ibid., (2), 26, 504, 1882.

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conglutin. Up to this time legumin was considered to be the proteid that is extracted from seeds with simple water and is precipitated by acids from the aqueous extract.

All proteids thus obtained had been regarded as identical by most investigators and were known either as legumin or plant casein. Although it had been suggested that different seeds yield different proteids, Ritthausen appears to have been the first to make this fact evident. Ritthausen prepared "legumin" from blue lupins, yellow, green and gray field peas, yellow garden peas, lentils, vetches, horse beans (Vicia faba), white and yellow beans (Phaseolus) and colza cake. The proteid of Phaseolus, Ritthausen afterwards found to be distinct from legumin, and one of us has, in the main, confirmed his later result and has named the proteid phaseolin.* Ritthausen afterwards considered the proteid which he obtained from colza cake to be an impure preparation of a different substance. His early analyses† of preparations from the leguminous seeds were fairly accordant, but he afterwards found that the soda lime method which was used in determining nitrogen gave too low results. He thereupon determined nitrogen anew by Dumas' method, and published a revised statement of the mean composition of legumin.‡

In another paper published shortly afterwards, Ritthausen withdrew the corrected figures for nitrogen, having found that they were too high, because the nitrogen of his later analyses was mixed with hydrogen. He therefore published a third set of figures for nitrogen and made a second revised statement of the mean composition of legumin.§

At this time Hoppe-Seyler (Physiol. Chemie, p. 75) and Th. Weyl (Zeitschrift f. Physiologische Chemie, 1, 72) stated that the proteids of plants are chiefly globulins and Weyl examined qualitatively a number of seeds, by extracting them with ten per cent. sodium chloride solution, and found proteids resembling in their reactions animal myosin and vitellin. They asserted that the substance called legumin by Ritthausen was doubtless originally a globulin and that the preparations of this substance described and analyzed by him were altered by the alkali which

* Report of the Conn. Agricultural Experiment Station, 1893, p. 186, and Journal of the American Chemical Society, vol. 16, p. 633.

† Die Eiweisskörper, &c., Bonn, 1872, pp. 159, 176.

‡ Pflüger, Archiv, XVI, 293, 1877.

§ Pflüger, Archiv, XVIII, 236, 1878.

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he used in extracting them and were not the proteids originally contained in the seeds. Ritthausen contended strongly against this view and maintained that his preparations were wholly unaltered by the alkali. He extracted several kinds of seeds with salt solution, precipitated the proteid by dilution with water and found that the preparations of legumin so made were not essentially different in composition from those obtained by extracting with dilute potash water.* He then examined his older preparations, made by extracting the seeds with weak alkali and showed that they were to a very considerable extent soluble in salt solution. The substance thus extracted had, in many cases, a different composition from that of the original preparation, and Ritthausen then concluded that all the preparations which he had previously described as legumin were, in fact, mixtures of the two proteids, one, soluble in salt solution after dissolving in potash water and precipitating with acid, similar to, but distinct from conglutin, and the other, originally soluble in salt solution but rendered insoluble in that fluid by treatment with alkalies. This latter he called legumin.

He then purified the legumin by extracting the mixed proteids from the seed with dilute alkali, neutralizing with acid, extracting the precipitate so produced with sodium chloride solution to remove proteids soluble in that fluid and then redissolving the residue, consisting mostly of legumin, in dilute alkali and reprecipitating with acetic acid.

Two preparations were so obtained, one from the pea and another from the horse bean (*Vicia faba*).

Ritthausen regarded his study of these preparations as showing that the substance from *Vicia faba* was a compound of tannic acid with the salt soluble proteid and that it was doubtful whether the horse bean contains legumin at all.

The preparation from the pea he finally considered to be legumin, having the following composition :

LEGUMIN OF PEA, RITTHAUSEN.

Carbon	51.34
Hydrogen	6.98
Nitrogen	17.48
Sulphur	0.45
Oxygen	23.75
	100.00

* Jour. f. Prakt. Chemie, 26, 504.

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This analysis represents the composition of legumin not in its original condition, but so altered as to be insoluble in saline solutions. Of the reactions of legumin we know little more than that it dissolves in salt solution and is precipitated by diluting with water.

In the following pages we give the outcome of our recent investigation into the composition and properties of legumin as contained in the seeds of the pea and the vetch.

Here as in former papers we have described our procedure with considerable, perhaps unnecessary, detail, but having often experienced great difficulty in understanding and repeating the work of our predecessors because of the vagueness of their statements, we have endeavored to describe our methods and results so fully and accurately that any who may wish to review our investigations experimentally may find it practicable to do so.

I. Proteids of the Pea.

One hundred grams of garden peas ground to pass a sieve of 1^{mm} mesh were extracted with petroleum naptha to remove oil, then dried by exposure to the air, and finally treated with one liter of ten per cent. sodium chloride solution. As the very viscid extract could scarcely be filtered through paper, an equal volume of ten per cent. sodium chloride solution was added, and after some time one half the solution passed the filter clear. This was saturated with ammonium sulphate, the resulting precipitate was filtered out, dissolved in salt solution and the liquid dialyzed free from chlorides. The proteid separated, as do all vegetable globulins thus far observed, in spheroids. No distinct crystals could be detected in this or any of our preparations from the pea. When the chloride had been removed by dialysis the precipitate was filtered out, washed with water and alcohol, dried over sulphuric acid and found to weigh 3.5 grams, being about 7 per cent. of the meal. Dried at 110° this preparation was analyzed with the following results :

Pea Legumin, 1.

Carbon	52.03
Hydrogen	6.96
Nitrogen	17.98
Sulphur, Oxygen	23.03
	100,00
Ash	0.41

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Another preparation was made by extracting 500 grams of pea meal with three liters of ten per cent. sodium chloride brine and after allowing the mixture, protected with thymol, to stand three days in a cool place, 1500^{cc} of the extract were decanted. Although very turbid, this was saturated with ammonium sulphate without filtering, and the precipitate produced was filtered out and dissolved in brine. The resulting solution was then filtered without much trouble and the clear filtrate dialyzed free from chlorides. After washing and drying, the globulin thus precipitated, and amounting to ten grams or about 5 per cent. of the meal, had the following composition:

PEA LEGUMIN, 2.

	I.	II.	Average.
Carbon	52.08	52.19	52.14
Hydrogen	7.06	6.95	7.01
Nitrogen	18.01	17.91	17.96
Sulphur	0.49	----	0.49
Oxygen	----	----	22.40
			100.00
Ash	0.33		

In order to obtain larger quantities of this proteid for fractional precipitations 800 grams of pea meal were treated with four liters of *twenty* per cent. sodium chloride solution, and by draining on filters over night about one half the solution applied to the meal, or two liters, was obtained as a clear yellow filtrate, which was saturated with ammonium sulphate, but for a reason, then unknown, very little proteid separated. Dilute acetic acid saturated with ammonium sulphate was then added in small amount and the proteid separated as a flocculent precipitate. This was filtered out and in order to remove the acid as completely as possible the precipitate was suspended in about four liters of saturated ammonium sulphate solution and again filtered out. The precipitate was then dissolved in ten per cent. sodium chloride solution and calcium carbonate added to neutralize the acid retained by the proteid. The solution then reacted alkaline with litmus owing to ammonium carbonate set free from the sulphate. The solution was next filtered very nearly clear and dialyzed until a large precipitate had formed. This precipitate was filtered out, dissolved in salt solution, filtered clear and dialyzed free from chlorides. The precipitated globulin was washed with water and alcohol and dried over sulphuric acid, giving fifty-two grams, in whose analysis, after drying at 110°, the following figures were obtained:

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PEA LEGUMIN, 3.

	I.	II.	Average.
Carbon	52.30	52.27	52.29
Hydrogen	7.06	6.98	7.02
Nitrogen	17.72	17.79	17.76
Sulphur	0.30	----	0.30
Oxygen	----	----	22.63
			100.00
Ash	0.53		

The solution filtered from this substance after its first precipitation by dialysis was saturated with ammonium sulphate, the resulting precipitate filtered out and dissolved in a little water, filtered clear and dialyzed. After removing the greater part of the salts by dialysis the precipitated globulin was filtered out, treated in the usual manner, and gave 14.2 grams of preparation 4, having, when dried at 110° the following composition :

PEA PROTEID, 4.

	I.	II.	Average.
Carbon	52.50	----	52.50
Hydrogen	6.74	----	6.74
Nitrogen	16.83	16.76	16.80
Sulphur	0.49	----	0.49
Oxygen	----	----	23.73
			100.00
Ash	0.33		

Preparation 3 when dissolved in ten per cent. salt solution was found to become turbid at 97° and after long heating in a boiling water bath slowly developed a coagulum. Preparation 4 contained a considerable quantity of proteid coagulating at a much lower temperature. It was accordingly dissolved, as far as possible, in a little ten per cent. salt solution and the insoluble matter filtered out. The clear filtrate was diluted with distilled water until the solution contained 0.66 per cent. of salt, when a not inconsiderable precipitate formed, which was filtered out and the filtrate saturated with ammonium sulplate. This produced a relatively abundant precipitate, which was filtered out and dissolved in water. This solution on heating became turbid at 52°, and on keeping for some time at this temperature a minute quantity of flocks separated. Filtered at 56°, turbidity occurred again at 62° and a few flocks formed at 66°. Filtered at 67°, the solution became turbid at 70°, the turbidity increasing above 75° to a heavy flocculent coagulum at 79°.

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It is evident from these results that we have in preparation 4 at least two proteids, one coagulating at 79°, the other being only slowly and imperfectly coagulated at 99°–100°; the former is readily soluble in very dilute salt solutions, the latter only slightly soluble in solutions containing less than one per cent. of salt. The filtrate from preparation 4 was dialyzed in water, but as no more globulin separated, the dialyzer was transferred to alcohol and the proteid thus completely thrown down. After washing with absolute alcohol and drying over sulphuric acid 12.31 grams of substance were obtained. This, of course, was a mixture of all the proteids extracted from the pea which had not been precipitated by dialysis in water. It was therefore treated with two per cent. salt solution, a large quantity of proteid which had been coagulated by the alcohol was filtered out, washed with water, with dilute and absolute alcohol, and dried over sulphuric acid. This preparation, 5, weighed 7.45 grams and gave the following results when analyzed, after drying at 110°.

PEA PROTEID, 5.

	I.	II.	Average.
Carbon	53.40	53.26	53.33
Hydrogen	6.92	7.03	6.98
Nitrogen	16.19	16.09	16.14
Sulphur	1.00	....	1.00
Oxygen	....	....	22.55
			100.00
Ash			0.32

The filtrate from 5 was saturated with ammonium sulphate, whereupon a small gummy precipitate appeared which was filtered out and dissolved in a small quantity of water. This solution when heated became turbid at 49° and flocculent at 60°; filtered at 75°, turbidity occurred on heating again to 72° and flocks formed at 79°. After heating to about 90° no more proteid was coagulated by boiling. The solution now contained a very small quantity of proteose.

Since acetic acid was used to separate the substance, from which 3, 4 and 5 were obtained, from the ammonium sulphate solution, it was necessary to obtain more of the proteids without the use of acid. It was found that the incomplete precipitation by ammonium sulphate was due to the use of twenty per cent. sodium chloride solution, in which less ammonium sulphate dis-

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solves than in a ten per cent. salt solution, not enough, in fact, to completely precipitate the proteid. The meal residue was therefore treated with water enough to reduce the strength of the salt solution still adhering to it to about ten per cent. A further considerable quantity of nearly clear extract was thus obtained, which, when saturated with ammonium sulphate, readily and completely parted with the proteid. This was filtered out, dissolved in ten per cent. brine, the solution filtered perfectly clear and dialyzed. After a large quantity of globulin had separated in the dialyzer its contents were filtered off, the precipitate was dissolved in ten per cent. salt solution and treated in exactly the same way as **3** had been. This preparation, **5**, weighed 37.5 grams and, dried at 110°, had the following composition:

PEA LEGUMIN, **6**.

	I.	II.	Average.
Carbon	52.37	----	52.37
Hydrogen	6.90	----	6.90
Nitrogen	17.95	17.95	17.95
Sulphur	0.39	----	0.39
Oxygen	----	----	22.39
			100.00
Ash	0.28		

The filtrate from the first precipitation, by dialysis, of this substance, when saturated with ammonium sulphate gave a precipitate which was dissolved in a little water and the resulting solution was filtered clear and dialyzed. After most of the salts were thus removed the separated globulin was filtered out, washed and dried, and gave 2.44 grams of preparation **7**, having the following composition, when dried at 110° :

PEA PROTEID, **7**.

	I.	II.	Average.
Carbon	52.09	52.02	52.06
Hydrogen	6.96	7.08	7.02
Nitrogen	16.75	16.57	16.66
Sulphur	0.55	----	0.55
Oxygen	----	----	23.71
			100.00
Ash	0.20		

This analysis is in fair accord with that of the similarly obtained preparation **4**.

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The filtrate from 7 was dialyzed into alcohol and then absolute alcohol was added to the solution until all the proteids separated. The precipitate thus produced was filtered out, washed with absolute alcohol, dried over sulphuric acid and found to weigh 7.1 grams. Since this preparation might be a mixture of any unprecipitated globulin, with albumin and proteose, if these were present, it was treated with water and the considerable quantity of proteid coagulated by alcohol was filtered out, washed thoroughly with water and then with absolute alcohol and dried over sulphuric acid. This gave 4.05 grams of preparation 8, which, when dried at 110°, had the following composition :

PEA PROTEID, 8.

	I.	II.	Average.
Carbon	53.60	53.47	53.54
Hydrogen	6.99	6.98	6.99
Nitrogen	16.72	16.65	16.69
Sulphur	1.01	....	1.01
Oxygen	....	....	21.77
			100.00
Ash	0.32		

The analysis of 8 agrees well with that of 5 and it is probable that these figures pretty nearly represent the composition of a second proteid (globulin or albumin) readily soluble in very dilute salt solutions.

Having thus found evidence of the presence of at least two proteids in the pea extract, one less soluble than the other in very dilute salt solutions, it became necessary to subject the less soluble and more abundant globulin to thorough fractioning in order to learn whether it was homogeneous or a mixture.

Twenty-five grams of 3 were therefore dissolved in 250^{cc} of five per cent. sodium chloride solution, filtered clear and the filter washed with 50^{cc} of the same salt solution. A portion of the preparation had, as is usually the case with vegetable globulins when dried, passed into an insoluble form. This insoluble matter when treated with salt solution gave a gummy residue, which was difficult to filter out. No estimate of the amount of this substance could be made.

The clear salt solution of the globulin was diluted with twice its volume of water, making 750^{cc} of a 1.67 per cent. solution, of

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sodium chloride. After standing over night the proteid which had precipitated on dilution was collected on a filter, washed with water and alcohol and dried over sulphuric acid. Preparation **9** was so obtained, weighing 5.1 grams and having, when dried at 110°, the composition given below.

The solution filtered from this substance was treated with an equal volume of water making 1500^{cc} of a brine containing 0.84 per cent. of salt, from which after standing some time a part of the proteid separated as a viscid layer at the bottom of the beaker. The solution was decanted and the precipitate washed and dried in the usual manner. This, **10**, weighed 5.29 grams. The decanted liquid was then dialyzed free from salt and the precipitated globulin treated in the usual manner, giving **11**, weighing 4.10 grams. About three-fifths of the original substance was thus recovered in three nearly equal fractions. The other two-fifths consisted largely of insoluble globulin. The composition of the fractions so obtained was as follows:

PEA LEGUMIN, FRACTIONS OF 2.

	9.			10.			11.		
	I.	II.	Average.	I.	II.	Average.	I.	II.	Average.
Carbon	52.49	52.23	52.36	52.31	52.09	52.20	52.25	52.25	52.25
Hydrogen	7.11	7.10	7.11	7.09	6.92	7.01	7.08	....	7.08
Nitrogen	17.96	18.05	18.01	17.98	17.96	17.97	17.88	17.84	17.86
Sulphur	0.35	....	0.35	0.35	....	0.35	....	....	22.81
Oxygen	....	....	22.17	22.27	....	22.47	....	....	
			100.00	100.00		100.00			100.00
Ash	0.22			0.61			0.20		

Again, twenty-five grams of preparation **5** were dissolved in 250^{cc} of five per cent. brine, the solution filtered, the residue washed with 50^{cc} of the same brine and the clear filtrate diluted with one and a half volumes of water, thus giving a two per cent. salt solution. After standing over night the precipitate was filtered out, washed with water and alcohol and dried over sulphuric acid. Preparation **12** so obtained weighed 8.58 grams.

The filtrate from **12**, on adding an equal volume of water and treating the precipitate as just described, yielded **13**, weighing 2.84 grams.

The filtrate from **13**, dialyzed free from salt, gave **14**, weighing 4.2 grams.

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PEA LEGUMIN, FRACTIONS OF 5.

	12.			13.	14.		
	I.	II.	Average.		I.	II.	Average.
Carbon.....	52.26	....	52.26	52.08	52.01	52.02	52.02
Hydrogen ..	6.96	....	6.96	7.04	....	7.20	7.20
Nitrogen ...	17.96	18.06	18.01	17.88	17.81	18.03	17.92
Sulphur	0.44	....	0.44	23.00	....	....	23.86
Oxygen	....	....	22.33		....	....	
			100.00	100.00			100.00
Ash.....	0.40		0.19	0.17			

Comparing the analyses of these fractions with each other and with that of the original substance, it is plain that they all represent a single proteid.

SUMMARY OF ANALYSES OF PEA LEGUMIN.

	1.	2.	3.	6.	9.	10.	11.
C. ..	52.03	52.14	52.29	52.37	52.36	52.20	52.25
H. ..	6.96	7.01	7.02	6.90	7.11	7.01	7.08
N. ..	17.98	17.96	17.76	17.95	18.01	17.97	17.86
S.	23.03	0.49	0.30	0.39	0.35	0.35	22.81
O.		22.40	22.63	22.39	22.17	22.47	
	100.00	100.00	100.00	100.00	100.00	100.00	100.00

	12.	13.	14.	Average.
C...	52.26	52.08	52.02	52.20
H...	6.96	7.04	7.20	7.03
N...	18.01	17.88	17.92	17.93
S. ..	0.44	23.00	22.86	22.45
O. ..	22.33			
	100.00	100.00	100.00	100.00

Ritthausen obtained from peas by extraction with salt solution and precipitation with water two preparations, the analyses of which are given below, A and B.*

By treating peas with very weak potash water, adding acid to neutralization, extracting the precipitate thus produced with salt solution and filtering out the insoluble matter, he obtained a solution from which, by adding water, a precipitate was thrown down whose composition is given below under C.

*Jour. f. prakt. Chem., 26, 504.

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PEA LEGUMIN.

	Ritthausen.			Osborne & Campbell. Average of 18 analyses on 10 preparations.
	A.	B.	C.	
Carbon	52.83	51.61	51.62	52.20
Hydrogen	7.27	7.08	6.96	7.03
Nitrogen	17.26	17.23	18.26	17.90
Sulphur	22.64	24.08	0.33	0.39
Oxygen			22.83	22.48
	100.00	100.00	100.00	100.00

Ritthausen's preparation C agrees fairly well with the average of our results. The preparations extracted directly from peas by salt solution would appear to be the same substance but less pure. We see no ground for Ritthausen's idea that his older preparations were mixtures of two proteids both originally soluble in salt solution, one of which, legumin, is rendered insoluble in salt solution by treatment with alkalies. It is much more probable that a part of the globulin in his preparations had assumed the insoluble condition during the process of separating, since nearly all globulins, to a greater or less extent, are prone to this change. The difference in composition between Ritthausen's original "legumin" and the substance extracted from it by salt solution is doubtless due to the greater purity of the latter. This view is supported by the close agreement in composition of this substance with those extracted by us directly from the pea. For this, the chief proteid of the pea, it is proper to retain the name *Legumin* first proposed by Braconnot.

The properties of legumin are as follows:

In water it is entirely insoluble.

In ten per cent. sodium chloride solution, when freshly prepared and not dried, it is readily soluble, but after washing with alcohol and drying over sulphuric acid, more or less becomes insoluble in salt solution. Dissolved in ten per cent. sodium chloride solution legumin is not precipitated by saturating the solution with magnesium sulphate, or sodium chloride. Saturated with sodium sulphate at 20°, no precipitate is produced; saturated at 25°, a turbidity appears; but saturated with sodium sulphate at 34°, all but a trace is thrown out of solution. By saturation with ammonium sulphate at common temperatures it is completely precipitated.

Dissolved in salt solution, legumin is not precipitated by mercu-

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ric chloride but gives a heavy precipitate on adding either picric, tannic, hydrochloric, nitric, sulphuric or acetic acid.

In water containing a very small quantity of acid, legumin readily dissolves and is precipitated by adding sodium chloride. It is readily soluble in dilute alkalies and alkali carbonates.

Adding to its solution glacial acetic acid and concentrated sulphuric acid, a violet color is produced. With cupric sulphate and caustic potash, after standing, a crimson red color appears, almost as red as that given by peptones. With Millon's and the xanthroproteic tests the usual reactions are given. When dissolved in ten per cent. sodium chloride solution and gradually heated, the solution becomes turbid at 97° and on long heating in a boiling water bath, a coagulum gradually separates.

II. Proteids of the Vetch.

One hundred grams of finely ground meal of the seed of the common vetch (*Vicia sativa*) were treated with water and the extract after filtering clear was saturated with ammonium sulphate. The small precipitate thereby produced was filtered out and dissolved in water; the resulting solution was filtered clear and dialyzed until free from chlorides. The globulin thus precipitated, after washing with water and with alcohol, weighed 1.04 grams. The meal residue was then treated repeatedly with ten per cent. sodium chloride solution and after filtering clear the extract was saturated with ammonium sulphate, the precipitated proteid filtered out and dissolved in brine. The resulting solution was filtered clear and dialyzed until free from chlorides. The globulin thus precipitated, when washed with water and alcohol, and dried over sulphuric acid, weighed 5.0 grams. When dried at 110° this preparation, **15**, had the following composition:

Vetch Legumin. **15.**

Carbon	52.45
Hydrogen	6.98
Nitrogen	18.04
Sulphur	0.50
Oxygen	22.03
	100.00
Ash	0.27

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The meal residue was next treated with two-tenths per cent. potash water, the extract filtered clear and neutralized with very dilute hydrochloric acid; the precipitate thus produced was dissolved in two-tenths per cent. potash water, the clear solution was neutralized with dilute hydrochloric acid and the precipitated proteid washed with water and alcohol and dried. This preparation **16** weighed 4.4 grams and gave the following results on analysis:

VETCH PROTEID, **16.**

	I.	II.	Average.
Carbon	52.41	52.43	52.42
Hydrogen	7.13	7.02	7.07
Nitrogen	16.55	----	16.55
Sulphur, Oxygen	----	----	23.96
			100.00
Ash	0.74		

Four kilograms of vetch meal were next treated with twelve liters of ten per cent. sodium chloride brine and the residue washed with the same solution. The extract and washings were partly cleared by subsidence, then saturated with ammonium sulphate. The precipitate so produced was dissolved in brine, but the resulting solution was very difficult to filter. The greater part of the suspended impurities was removed by passing the extract through a loose bed of filter paper pulp and the proteid was again separated by saturation with ammonium sulphate. This precipitate was dissolved in brine and the solution, kept cold, then filtered perfectly clear. This solution was dialyzed in two portions, D and E. After nearly freeing from chlorides, a large precipitate formed in each dialyzer, which was filtered out. That obtained from E was washed with water and with alcohol as long as any coloring matter was extracted, and was then dried over sulphuric acid giving 120 grams of a slightly pink powder, which will be designated F. That from D was redissolved in ten per cent. sodium chloride brine, the solution filtered perfectly clear and dialyzed until free from chlorides. All but a trace of proteid was thus thrown down. The precipitate was washed thoroughly with water and with alcohol and dried over sulphuric acid yielding preparation **17**, which weighed 90 grams and was very slightly colored. After drying at 110°, this preparation had the following composition:

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VETCH LEGUMIN, 17.

	I.	II.	Average.
Carbon	51.98	51.97	51.98
Hydrogen	6.94	6.89	6.92
Nitrogen	17.96	18.00	17.98
Sulphur	0.45	....	0.45
Oxygen	....	....	22.67
			100.00
Ash	0.20		

The filtrates from the first dialysis of solutions D and E were separately saturated with ammonium sulphate, the precipitates obtained were dissolved in water and the solutions filtered and dialyzed. The precipitate from D, thrown down by dialysis, was redissolved in salt solution and again precipitated by dialysis. The two preparations of globulin thus obtained were washed with water and with alcohol and dried over sulphuric acid, that from D weighed 4.11 grams, forming preparation **18**, and that from E gave preparation **19**, weighing 7.67 grams. On analyzing these preparations, dried at 110°, the following results were obtained :

VETCH LEGUMIN.

	18.	19.
Carbon	52.21	52.18
Hydrogen	6.82	6.82
Nitrogen	17.99	17.99
Sulphur	0.37	0.36
Oxygen	22.61	22.65
	100.00	100.00

The filtrate from the first precipitation by dialysis of **18** was united with the filtrate from **19** and the heat coagulation point determined in a portion of the solution, in which ten per cent. of sodium chloride had been dissolved. This solution became turbid at 56° and flocks separated at 63° in considerable quantity. After heating to 70° for some time and filtering, turbidity occurred on heating to 71° and a flocculent coagulum formed at 73°, about the same in amount as at 63°. After heating to 78°, the solution was filtered and again heated, the turbidity forming a third time at 79° and flocks at 83° in smaller quantity than before. This slow and incomplete coagulation does not necessarily indicate the

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presence of several coagulable proteids in the solution, for there is no temperature-interval between the successive coagula, the temperature at which turbidity occurs and a flocculent coagulum develops being determined, after the first coagulum has formed, by the temperature at which the solution was filtered. Each time the solution becomes turbid at a temperature just above that to which it had been previously heated and a flocculent coagulum separates at three or four degrees higher.

The presence of salts has much influence on the coagulation point, for another portion of this same solution, to which no salt had been added, became turbid at ten degrees lower than the portion wherein ten per cent. of sodium chloride had been dissolved and gave the last flocculent coagulum at a temperature ten degrees higher.

The solution, portions of which had served for the foregoing observations, was then dialyzed into alcohol until concentrated to one half its original volume, when a considerable precipitate formed which was filtered out, washed with alcohol and dried over sulphuric acid. This substance consisted of a mixture of all the proteids remaining in solution after separating the globulin, as described. Any albumin or globulin which might be contained in this precipitate would probably be largely if not wholly coagulated by the long treatment with alcohol and the subsequent drying. This preparation was therefore very finely pulverized and extracted thoroughly with water. The insoluble residue was then washed with alcohol and dried, yielding 13.52 grams of preparation **20**, which was found to have the following composition:

VETCH PROTEID, **20**.

	I.	II.	Average.
Carbon	53.45	53.65	53.55
Hydrogen	6.67	6.73	6.70
Nitrogen	16.46	....	16.46
Sulphur	1.02	....	1.02
Oxygen	....	....	22.27
			100.00
Ash	0.29		

The solution filtered from **20** was further dialyzed into alcohol and a second precipitate obtained, which, when washed with alcohol and dried, weighed 5.64 grams and was composed as follows:

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VETCH PROTEID, 21.

	I.	II.	Average.
Carbon	52.55	52.66	52.60
Hydrogen	6.70	6.95	6.83
Nitrogen	16.53	16.76	16.69
Sulphur	1.23	....	1.23
Oxygen	....	....	22.65
			100.00
Ash	0.65		

The filtrate from the precipitate produced by the first dialysis into alcohol, from which preparations **20** and **21** had been obtained, was further dialyzed into alcohol yielding a second precipitate which, when washed with alcohol and dried over sulphuric acid, weighed 2.21 grams and formed preparation **22**. This consisted of proteose and, after drying at 110°, had the composition as follows:

VETCH PROTEOSE, 22.

	I.	II.	Average.
Carbon	50 95	50.76	50.85
Hydrogen	6.78	6.72	6.75
Nitrogen	16.53	16.79	16.65
Sulphur, Oxygen	....	....	25.75
			100.00
Ash	2.18		

Comparing the composition of **21** with that of **20**, it is seen that, excepting carbon, the figures agree quite well. **21**, however, contains one per cent. less carbon than **20**, which is easily explained by its being a mixture of the proteose represented by **22**, and the proteid represented by **20**. Such a mixture would be expected from the method of preparation.

If **20** is compared with **5** and **8**, obtained in a similar manner from the pea, by dialysis of its extracts into alcohol, after precipitation of the greater part of the globulin contained in these extracts by dialysis in running water, it will be observed that they rather closely agree. It is hardly possible by this method to obtain entirely pure preparations, but our results show that the vetch and pea both contain another proteid that is different from legumin in composition and in properties.

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is no temperature-interval between the succes
temperature at which turbidity occurs and a
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which it had been previously heated
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LEGUMIN AND OTHER PROTEIDS.

VETCH PROTEID, 91.

I.	52.55	6.70
II.	52.66	6.95
Average.	52.60	6.83

produced by the first dialysis
ed 80 and 91 had been
ed by yielding a second pre
and dried over sulphuric
ation 82. This gave

...ed, a
neutralized
...pitate which re-
...t. potash water, and
...wn down by neutralizing
...ing, 12.4 grams of **23** were
...omposition:

VETCH PROTEID, 23.

	I.	II.	Average.
----------	53.00	52.99	53.00
----------	6.91	7.02	6.97
----------	16.45	....	16.45
----------	0.53	....	0.53
...en ----------	....	....	23.05
			100.00
Ash ----------	0.92		

If this analysis is compared with that of **16**, it will be noted that, although they agree in nitrogen content, they differ as respects carbon. The sulphur found in **23** would indicate that **23** is a mixture of legumin with other substances. It seems to us probable that it is mainly legumin which escaped extraction by the salt solution through imperfect pulverization of the meal or its incomplete exhaustion by the brine, or because it was present in

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a form which it may have assumed in the
tion of the solvents to which the meal
ur experience with other seeds that
austing the seed with salt solu-
st cases, it is impossible to

legumin found in the
following fractional

270

en per cent.
extract was
s, thus precipi-
ne. The solution
ight per cent. of salt.
all amount of insoluble
ater was added. On stand-
precipitated collected on the
r as a sticky deposit, leaving the
latter was then decanted and the
of proteid washed with water, which
ue and become brittle, so that it was easily
powder.

g repeatedly with water the proteid was thor-
ed with dilute alcohol, then with absolute alcohol,
over sulphuric acid. This preparation, **24**, weighed
ams.

ne solution decanted from **24** was cooled in an ice box over
ight and the clear supernatant liquid poured from the perfectly transparent semifluid layer which had thus formed on the bottom of the beaker. After washing and drying, 12.9 grams of preparation **25** were obtained. The solution decanted from **25** was mixed with an equal volume of distilled water and left over night in the ice box. A transparent layer of proteid was again deposited, which, when washed and dried, yielded 4.00 grams of **26**.

The solution decanted from **26** was saturated with ammonium sulphate, the precipitated proteid dissolved in salt solution, and after filtering, the proteid was precipitated by dialysis. The globulin thus separated, after washing and drying, weighed 3.35 grams, and formed preparation **27**.

The following figures were obtained by analyzing these preparations when dried at 110°.

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To facilitate comparison these analyses are here tabulated.

	Pea Proteid.		Vetch Proteid.
	5.	8.	20.
Carbon	53.33	53.54	53.55
Hydrogen	6.98	6.99	6.70
Nitrogen	16.14	16.69	16.46
Sulphur	1.00	1.01	1.02
Oxygen	22.55	21.77	22.27
	100.00	100.00	100.00

It will be noted that this proteid contains more carbon and less nitrogen than legumin and nearly twice as much sulphur.

Whether it is a globulin soluble in extremely dilute salt solutions or an albumin soluble in pure water, we have not as yet undertaken to ascertain, for want of time.

The residue of the meal extracted, as described, with salt solution, was treated with two-tenths per cent. potash solution, a portion of the alkali extract was filtered clear and neutralized with very dilute hydrochloric acid. The precipitate which resulted was dissolved in two-tenths per cent. potash water, and after filtering perfectly clear, again thrown down by neutralizing with hydrochloric acid. After drying, 12.4 grams of **23** were obtained, having the following composition:

Vetch Proteid, 23.

	I.	II.	Average.
Carbon	53.00	52.99	53.00
Hydrogen	6.91	7.02	6.97
Nitrogen	16.45	----	16.45
Sulphur	0.53	----	0.53
Oxygen	----	----	23.05
			100.00
Ash	0.92		

If this analysis is compared with that of **16**, it will be noted that, although they agree in nitrogen content, they differ as respects carbon. The sulphur found in **23** would indicate that **23** is a mixture of legumin with other substances. It seems to us probable that it is mainly legumin which escaped extraction by the salt solution through imperfect pulverization of the meal or its incomplete exhaustion by the brine, or because it was present in

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the salt-insoluble form, a form which it may have assumed in the seed itself, or under the action of the solvents to which the meal was subjected. It has been our experience with other seeds that extractions with alkali, after exhausting the seed with salt solution, yields products which, in most cases, it is impossible to purify.

In order next to determine whether the legumin found in the vetch seed is a single proteid or a mixture, the following fractional precipitations were made.

One kilogram of the meal was extracted with ten per cent. sodium chloride solution and, after filtering clear, the extract was saturated with ammonium sulphate and the proteids, thus precipitated, dissolved in 300 c.c. of ten per cent. brine. The solution now measured 400 c.c. and contained about eight per cent. of salt. After filtering perfectly clear, from a small amount of insoluble matter, an equal volume of distilled water was added. On standing a short time the proteid thus precipitated collected on the sides and bottom of the beaker as a sticky deposit, leaving the solution nearly clear. The latter was then decanted and the translucent, gummy mass of proteid washed with water, which caused it to turn opaque and become brittle, so that it was easily rubbed to a coarse powder.

After washing repeatedly with water the proteid was thoroughly washed with dilute alcohol, then with absolute alcohol, and dried over sulphuric acid. This preparation, **24**, weighed 13.4 grams.

The solution decanted from **24** was cooled in an ice box over night and the clear supernatant liquid poured from the perfectly transparent semifluid layer which had thus formed on the bottom of the beaker. After washing and drying, 12.9 grams of preparation **25** were obtained. The solution decanted from **25** was mixed with an equal volume of distilled water and left over night in the ice box. A transparent layer of proteid was again deposited, which, when washed and dried, yielded 4.00 grams of **26**.

The solution decanted from **26** was saturated with ammonium sulphate, the precipitated proteid dissolved in salt solution, and after filtering, the proteid was precipitated by dialysis. The globulin thus separated, after washing and drying, weighed 3.35 grams, and formed preparation **27**.

The following figures were obtained by analyzing these preparations when dried at 110°.

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VETCH LEGUMIN.

	24.	25.	26.	27.
Carbon	52.05	51.78	52.17	52.04
Hydrogen	6.99	6.89	6.92	7.06
Nitrogen	18.02	18.06	17.70	18.02
Sulphur	0.56	0.48	23.21	22.88
Oxygen	22.38	22.79		
	100.00	100.00	100.00	100.00

Several grams of preparation E, described on page 276, were dissolved in a very little two-tenths per cent. potash water, the solution was diluted considerably with distilled water and carbonic acid gas passed through it. At first the solution remained clear, but after a time the proteid suddenly and almost completely separated as a voluminous precipitate, the filtrate from which yielded but a trace of proteid on saturating with ammonium sulphate. The precipitate was washed with water and then treated with salt solution. A part dissolved and the rest was converted into a swollen gelatinous mass which rendered filtration impossible. After standing over night the solution was poured off and the gummy residue was washed by decantation, at first with salt solution and then with water. On washing out the salt, the residue lost its gummy character and became a dense, rapidly settling precipitate which was readily collected on a filter and completely washed with water and then with alcohol. After drying over sulphuric acid it furnished 2.62 grams of preparation **28.** This peculiar behavior of legumin which has lost its solubility in salt solution, we have observed in a number of cases.

E, when treated directly with salt solution, behaved in exactly the same manner as the precipitate obtained by passing carbonic acid through its solution in dilute potash water, that is, a part dissolved and a part remained as a gummy residue, which was dehydrated (?) by washing with water. The saline solution described above, which had been decanted from the part of the carbonic acid precipitate which was insoluble in salt solution, was filtered clear and dialyzed free from chlorides. The precipitate which resulted was filtered out, washed and dried in the usual manner, and yielded **29.** These two preparations were found to have the following composition:

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VETCH LEGUMIN.

	28.	29.
Carbon	52.11	51.89
Hydrogen	6.82	6.88
Nitrogen	18.17	18.09
Sulphur	0.53	0.40
Oxygen	22.37	22.74
	100.00	100.00
Ash	0.27	0.13

Several grams of preparation **17** were dissolved in a little two-tenths per cent. potash water and the resulting clear solution was neutralized with dilute acetic acid, thereby precipitating the proteid. A portion of this precipitate was tested with ten per cent. sodium chloride solution and found to dissolve to a large extent and on warming to 50° nearly all went into solution. The remainder of the precipitate was washed, dried and analyzed with the following results:

VETCH LEGUMIN, **30.**

Carbon	52.06
Hydrogen	6.80
Nitrogen	17.98
Sulphur	0.53
Oxygen	22.63
	100.00
Ash	0.15

Another portion of preparation **17** was treated with two-tenths per cent. hydrochloric acid and yielded a clear solution, which was neutralized with one-half per cent. sodium carbonate solution. The resulting precipitate was partly soluble in ten per cent. salt solution. It was washed and dried and, as preparation **31**, gave the following figures when analyzed:

VETCH LEGUMIN, **31.**

Carbon	52.12
Hydrogen	6.68
Nitrogen	18.20
Sulphur	0.40
Oxygen	22.60
	100.00
Ash	0.15

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For convenience of comparison the analyses of legumin from the vetch are brought together in the following tables:

SUMMARY OF ANALYSES OF VETCH LEGUMIN.

	15.	16.	18.	19.	24.	25.
Carbon	52.45	51.98	52.21	52.18	52.05	51.78
Hydrogen	6.98	6.92	6.82	6.82	6.99	6.89
Nitrogen	18.04	17.98	17.99	17.99	18.02	18.06
Sulphur	0.50	0.45	0.37	0.36	0.56	0.48
Oxygen	22.03	22.67	22.61	22.65	22.38	22.79
	100.00	100.00	100.00	100.00	100.00	100.00

	26.	27.	28.	29.	30.	31.
Carbon	52.17	52.04	52.11	51.89	52.06	52.12
Hydrogen	6.92	7.06	6.82	6.88	6.80	6.68
Nitrogen	17.70	18.02	18.17	18.09	17.98	18.20
Sulphur	23.21	22.88	0.53	0.40	0.53	0.40
Oxygen			22.37	22.74	22.63	22.60
	100.00	100.00	100.00	100.00	100.00	100.00

It will be seen from the following statement that the composition of legumin from the pea is identical with that from the vetch.

LEGUMIN.

	PEA	VETCH
	Average of 18 analyses on 10 preparations.	Average of 13 analyses on 12 preparations.
Carbon	52.20	52.09
Hydrogen	7.03	6.88
Nitrogen	17.93	18.02
Sulphur	0.39	0.46
Oxygen	22.45	22.55
	100.00	100.00

What we have already stated concerning the properties and reactions of pea legumin applies strictly to that from the vetch except in two particulars. The solutions of pea legumin in ten per cent. brine when heated nearly to boiling become turbid and, after a time, a considerable coagulum separates in the form of a semi-solid clot. Similar solutions of the vetch legumin, on the other hand, remain perfectly clear, even after prolonged boiling.

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Many carefully conducted experiments made with the legumin from each of these seeds, wherein the same quantity of globulin was dissolved in the same amount of salt solution of the same strength, were carried out side by side, but always with the same results, the pea legumin coagulating to a greater or less extent while the vetch legumin remained wholly unaffected.

That this difference is due to some foreign substance is indicated by the following experiment. A quantity of ten per cent. sodium chloride extract of pea meal was filtered clear and divided into two parts, one of which was dialyzed directly, the other was saturated with sodium chloride and filtered clear. The latter solution was less viscid and much more easily filtered, presumably due to the removal of gum. This solution, saturated with salt, was then dialyzed.

The globulin precipitated by dialysis from each of the above-named solutions, was dissolved in brine to new solutions containing ten per cent. of globulin and eight per cent. of sodium chloride. When these two solutions were heated, side by side, in the same water bath and for the same length of time, a most marked difference was observed in the quantities of coagulum that appeared. Each solution contained a small quantity of the proteid coagulating at about 80°, so that after heating to 85° for some time, they were filtered clear and again heated.

Each solution then became turbid at 93° and, after heating the bath to boiling for a little time, the solution of the globulin from the salt saturated extract became curdy, from the separation of a moderate quantity of coagulum, while that from the unsaturated extract set to a firm opaque jelly, so that the tube could be inverted without displacement of its contents.

The second difference noted was very slight, but appeared to be constant. By precipitating the legumin from the pea by dialysis, the proteid was obtained in the forms of spheroids which showed little tendency to adhere in masses, while that from the vetch was always obtained in more or less coherent lumps which, however, were not at all fluid and gummy, but were easily broken up on stirring. In our opinion, the legumin from these two seeds is one and the same substance, or must, at least for the present, be so regarded.

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Summary.

1. So far as we have investigated, peas and vetches contain the same proteids, which are nearly if not entirely soluble in ten per cent. sodium chloride solution.

2. The greater part of these proteids consists of a globulin, the *Legumin* of Braconnot, which is readily precipitated by dialyzing its salt solutions.

The prevalent idea that legumin is soluble only in acids and alkalies is erronous, it having been proved, notably by Ritthausen, to be a true globulin. The composition of legumin, as shown by the average of our accordant analyses of thirty-one preparations obtained from the seeds of peas and vetches, is the following:

Legumin.

Carbon	52.15
Hydrogen	6.96
Nitrogen	17.98
Sulphur	0.43
Oxygen	22.48
	100.00

Legumin is abundantly soluble in solutions containing above five per cent. of sodium chloride, in those containing less salt it is not so soluble, the amount held in solution decreasing as the salt content diminishes, so that it is but sparingly soluble in solutions containing less than one per cent. of salt. By dilution with water, strong saline solutions of legumin are abundantly precipitated.

By saturation with sodium chloride or magnesium sulphate, its sodium chloride solutions are not precipitated; by saturation with sodium sulphate at 25° they are not precipitated, but at higher temperatures more or less is thrown down, and by saturation with sodium sulphate at 34°, precipitation is very nearly complete. With nitric acid, Millon's and Adamkiewic's reagents it gives the usual proteid reactions.

With strong solutions of legumin the biuret test gives a violet color at first, which on standing becomes crimson red, similar to the color produced by peptones.

The legumin obtained by us from the vetch is not coagulated by heat nor even rendered turbid by prolonged boiling of strong solutions.

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The legumin prepared by us from the pea is partly coagulated by heating strong solutions in a boiling water bath, and sets to a firm jelly after thus heating for some time. These differences in their behavior on heating, and a greater tendency of the vetch legumin to cohere in semi-solid lumps when precipitated by dialysis, are the only points of dissimilarity which a rigid comparison of preparations from the two seeds has revealed.

These differences, in our opinion, are due to the substances with which the proteid is associated in the two seeds, for saturation of the pea extracts with sodium chloride, before precipitating the legumin by dialysis, greatly diminished the amount of coagulum given by the pea legumin.

3. Besides the legumin, the pea and vetch contain another proteid in small amount, either an albumin or a globulin, soluble in extremely dilute salt solutions, and coagulated by heating its solutions to 80°. This substance we have not studied further than to make two preparations for analysis from the pea and one from the vetch. These were obtained in an insoluble form by coagulating with alcohol, so that the properties and reactions were not determined. The composition of this proteid is shown by the following average of three closely agreeing analyses:

PROTEID OF PEA AND VETCH.

Carbon	53.48
Hydrogen	6.89
Nitrogen	16.43
Sulphur	1.01
Oxygen	22.19
	100.00

4. In addition to the foregoing proteids a very little *proteose* was found in the extracts of both these seeds.

5. No attempt has yet been made to determine the total quantity of proteids in these seeds, nor to study minutely the proteids that occur in them in small proportion.

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CONGLUTIN AND VITELLIN.

By Thomas B. Osborne and George F. Campbell.

Review of the literature relating to the plant proteids hitherto described as Conglutin and Vitellin, shows that the subject is in great confusion, which can only be cleared up by a thorough examination of the seeds from which these proteids are said to have been obtained. This is the more important, because of late years various investigations have been made in which these proteids have figured as the subject of study, while the fact, that the purity or even the identity of the proteid employed is very doubtful, has been entirely overlooked or ignored. Thus the results of observations on the globulin of lupins have been applied to the globulin of the squash, hemp and other seeds, it being apparently unknown that these two proteids are very distinct substances. Further, the composition and reactions of most of these bodies have never been adequately studied, nor the means of preparing them in a state of purity ascertained. Recent authors are mostly content to call these proteids vegetable vitellin and to assume, with little reason, that the proteid from the many seeds in which vitellin has been said to occur is one and the same substance. With the object of determining, so far as may be practicable, the true relations of the globulins found in the various seeds hitherto alleged to contain conglutin and vitellin, this investigation was undertaken.

Almonds.

The proteid first discovered, which has since been known as conglutin, was found in the seed of the almond by Proust (Jour. de phys., de chim., d'histoire naturelle et des arts 54, 199) and by him named Amandin.

Dumas and Cahours (Jour. f. prakt. Chem. 28, 398) described and analyzed preparations obtained from almonds, peach and plum seeds, and considered them to be legumin, identical with that of a large number of other seeds.

According to Rochleder (Ann. der Chem. u. Pharm. 46, 155), the proteid described by Dumas and Cahours is different from legumin as understood by Liebig and others. Norton (Am. Jour. Science (2) V. 22) analyzed proteid preparations which he obtained from the almond and considered them to be legumin.

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Ritthausen (Eiweisskörper, Bonn, 1872) described the proteid of the almond under the name conglutin. He later (Jour. f. prakt. Chem. 26, 422, 1882) obtained from the peach kernel a proteid which he considered to be conglutin, identical with that of almonds and lupins.

The details of our investigation are as follows: A quantity of sweet almond meats deprived of the brown skin (tegmen) were crushed and treated with ether to remove oil. Seventy-five grams of the oil-free meal were then extracted with ten per cent. sodium chloride solution, the extract was filtered clear and dialyzed until free from chlorides. The globulin separated at first in minute spheroids, which, on settling to the bottom of the dialyzer, united, forming a viscid semi-fluid translucent mass of a pale straw color. After decanting the solution, the globulin, which had separated, was again dissolved in ten per cent. sodium chloride brine and reprecipitated by dialysis. The proteid, obtained in the same condition as before, was washed with water, and with alcohol, dilute at first and afterwards gradually increased in strength, and finally was dehydrated with absolute alcohol and dried over sulphuric acid. This preparation, **1**, weighed 6.72 grams, was a snow white, dense powder, and, after drying at 110°, gave the following results on analysis:

AMANDIN, 1.

				Average.
Carbon	51.49	51.32	----	51.41
Hydrogen	7.33*	6.86	----	6.86
Nitrogen	19.29	19.52	19.62	19.47
Sulphur	0.39	----	----	0.39
Oxygen	----	----	----	21.87
				100.00
Ash	0.24			

Another preparation of this globulin was made by crushing a quantity of fresh, shelled, "Jordan almonds," and extracting the oil with petroleum naphtha. After freeing from naphtha, the greater part of the skins was separated by sifting. 100 grams of the meal were then extracted with one liter of water and the solution filtered and saturated with ammonium sulphate. The precipitate produced was filtered out, dissolved in water, the

* Omitted in average.

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resulting solution filtered perfectly clear and dialyzed until free from chlorides. The proteid which on dialysis deposited with the same appearance and characters as the first preparation, was washed with water, dilute alcohol, stronger alcohol and then dehydrated with absolute alcohol and dried over sulphuric acid. Sixteen grams were obtained, equal to sixteen per cent. of the meal. This preparation, owing to the seed-integument, which had been but partly removed, was somewhat red in color. After drying at 110°, analysis gave the following results:

AMANDIN, 2.

			Average.
Carbon	51.49	....	51.49
Hydrogen	6·85	....	6.85
Nitrogen	19.27	19.05	19.16
Sulphur	0.44	....	0.44
Oxygen	....	....	22.06
			100.00
Ash	0.80		

For a third preparation Jordan almonds were drenched with hot water for a moment to loosen the skins, which were then easily detached; the meats were squeezed in a drug press to separate the greater part of the oil. The remainder of the oil, after dehydrating the pressed meats with absolute alcohol, was extracted with naphtha. The residue was freed from naphtha by evaporation and ground to a fine powder. There was thus obtained from 900 grams of almonds 380 grams of oil-free meal. This was thoroughly extracted with ten per cent. sodium chloride brine and the extract filtered. A turbid liquid resulted which was saturated with ammonium sulphate. The proteid thus precipitated was dissolved in ten per cent. sodium chloride brine and the solution after filtering perfectly clear was dialyzed until nearly free from chlorides. The solution was then decanted from the semi-fluid, viscid precipitate which had formed, and this was washed with water and alcohol, dehydrated with absolute alcohol and dried over sulphuric acid. The proteid thus obtained weighed sixty-six grams. The filtrate from this preparation was saturated with ammonium sulphate, the precipitate was filtered out, dissolved in a little water and the filtered solution was dialyzed. This second dialysis yielded twenty-seven grams more of globulin, which were added to that before obtained, making in all ninety

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three grams, being twenty-four and one-half per cent. of the oil-free meal. Analysis of this preparation, **3**, dried at 110°, gave results as follows:

AMANDIN, 3.

			Average.
Carbon	51.18	----	51.18
Hydrogen	6.99	----	6.99
Nitrogen	19.30	19.37	19.33
Sulphur	0.48	----	0.48
Oxygen	----	----	22.02
			100.00
Ash	0.35		

A portion of **3** was dissolved in sodium chloride solution and dialyzed into dilute alcohol in the hope of obtaining the globulin in the form of crystals. No distinct crystals resulted, and after remaining about two weeks in alcohol the precipitated proteid was readily redissolved in salt solution, not having been coagulated by the alcohol, and the clear solution was dialyzed in water until free from chlorides. After washing and drying in the usual manner this preparation, **4**, was analyzed:

AMANDIN, 4.

	I.	II.	Average.
Carbon	51.39	51.32	51.36
Hydrogen	6.99	6.90	6.95
Nitrogen	19.32	19.36	19.34
Sulphur	0.45	----	0.45
Oxygen	----	----	21.90
			100.00
Ash	0.20		

Peach Kernel.

Ritthausen states that peach seeds contain the same proteid as the almond, a fact in harmony with the close botanical relations of the two plants.

We obtained this proteid from peach pits in the following manner: The seeds were freed from the skin (tegmen) by cutting it away with a knife and were then ground with ether to a powder and freed from oil. Only a small quantity of seeds, yielding but twenty grams of oil-free meal, were at the time available. This was extracted with ten per cent. sodium chloride solution and the clear filtered extract dialyzed. The globulin separated in sphe-

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roids, which settled to a translucent viscid semi-fluid mass like that from the almonds. The solution, when freed from chlorides by dialysis, was decanted from the precipitate and the latter was washed with water, alcohol and absolute alcohol and dried over sulphuric acid ; 2.44 grams or 12.2 per cent. of the meal were so obtained. Analysis of this preparation gave the following results:

AMANDIN, FROM THE PEACH, 5.

			Average.
Carbon	51.06	51.02	51.04
Hydrogen	6.86	6.79	6.83
Nitrogen	19.20	19.35	19.28
Sulphur	0.48	....	0.48
Oxygen	....	....	22.37
			100.00
Ash	0.62		

Owing to the small quantity of 5, it was not possible to compare its reactions throughout with those of amandin from the almond, but, so far as could be observed, the two were identical in all respects, and there can be no doubt that they are the same substance.

In the following table the foregoing results may be compared with those obtained by earlier investigators, in their work upon the proteid of the almond, peach and plum :

AMANDIN.

	Dumas and Cahours.		Löwenburg.		Norton.	
	Almonds.	Plums.	Almonds.		Almonds.	
Carbon	50.89	50.93	51.10	50.50	50.97	49.16
Hydrogen	6.71	6.73	7.20	6.56	6.64	6.51
Nitrogen	18.93	18.64	....	17.33	17.15	17.43
Sulphur	....	....	....	0.32	0.27	0.41
Phosphorus	....	....	....	1.05	0.57	2.21
Oxygen	23.47	23.70	....	24.24	24.40	24.27
	100.00	100.00		100.00	100.00	100.00

Ritthausen.

	Almonds.	Peach.
Carbon	50.44	50.82
Hydrogen	6.85	6.94
Nitrogen	18.61	18.60
Sulphur	0.43	0.32
Oxygen	23.67	23.32
	100.00	100.00

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AMANDIN.

	Osborne and Campbell. Almonds.				Peach.	
	1.	2.	3.	4.	5.	Average.
Carbon	51.41	51.49	51.18	51.36	51.04	51.30
Hydrogen	6.86	6.85	6.99	6.95	6.83	6.90
Nitrogen	19.47	19.16	19.33	19.34	19.28	19.32
Sulphur	0.39	0.44	0.48	0.45	0.44	0.44
Oxygen	21.87	22.06	22.02	21.90	22.37	22.04
	100.00	100.00	100.00	100.00	100.00	100.00

Amandin, that has been dried over sulphuric acid, when mixed with cold water dissolves to a very slight extent and forms a gummy plastic mass. In water heated to about 98° amandin melts to a transparent mass and a considerable portion goes into solution, which in part separates out on cooling, and is redissolved on heating again. Boiling the solution causes but a slight turbidity.

The precipitate formed by cooling the hot water solution of amandin, dissolves completely on addition of a little nitric acid, but if more nitric acid be added, a precipitate falls which dissolves on warming and reappears on cooling in exactly the manner of a proteose.

In ten per cent. sodium chloride solution this proteid dissolves readily to a slightly opalescent liquid, no insoluble "albuminate" being formed by drying, as is the case with most vegetable globulins.

A solution containing ten per cent. of amandin dissolved in ten per cent. sodium chloride brine gives an abundant precipitate when poured into much distilled water, but if only a small amount of proteid is dissolved in the brine no precipitate is produced by dilution.

Salt solution of amandin is not precipitated by saturating with sodium chloride. By saturating with magnesium sulphate it is partly thrown down. Saturation with sodium sulphate or ammonium sulphate completely precipitates it.

Nitric acid added to the sodium chloride solution forms a precipitate soluble in an excess of acid which, on heating, gives the usual xanthoproteic reaction.

With mercuric chloride solution no precipitate is formed.

With picric acid and also with tannic acid heavy precipitates are produced.

Amandin is readily soluble in very dilute acetic acid. The

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acetic solution yields an abundant precipitate with potassium ferrocyanide that is difficultly soluble in an excess of this salt to a solution precipitable by diluting with water. In concentrated glycerine the dry proteid dissolves quite readily, the clear solution yielding a considerable precipitate on adding absolute alcohol.

Concentrated hydrochloric acid dissolves it, with development of a violet-blue color on standing. By heating in quite dilute sulphuric acid a solution is obtained which becomes turbid on cooling, the proteid being far less soluble in sulphuric than in hydrochloric or acetic acids. With the biuret test and also with glacial acetic acid and concentrated sulphuric acid together, solutions of this globulin give a fine violet color.

After solution in very dilute potash water and precipitation by neutralizing with acetic acid, amandin retains its original solubility in salt solutions.

A ten per cent. sodium chloride solution, containing five per cent. of amandin, becomes turbid when heated to 75°, and at 80° flocks form in small quantity which slowly increase on gradually raising the temperature, but only a small part of the proteid is coagulated even by boiling.

Having thus, as we believe, established this proteid as a chemical species quite distinct from all others hitherto investigated, it is proper to restore the designation *Amandin* given it by Proust, its discoverer, and to discard for it the names vitellin and conglutin, which are associated with many erroneous statements as to its occurrence, composition and characters.

Walnut, Juglans regia.

Ritthausen (Jour. f. prakt. Chem., 24, 257) prepared the proteid from this seed, but owing to the large amount of tannin present in the skins, he found much difficulty in obtaining satisfactory results.

As Ritthausen's preparations differed widely in composition, and as he has published nothing respecting the properties of this proteid, we have made several preparations with the following results.

A quantity of walnut meats was crushed, freed from oil by extracting with petroleum naphtha, and the greater part of the skins removed by sifting. One hundred grams of this meal were then extracted with ten per cent. sodium chloride brine and, after filtering, eight-tenths of the salt solution applied was recovered as a

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clear extract corresponding to about eighty grams of meal. This was saturated with ammonium sulphate and the resulting precipitate filtered out and treated with salt solution. Much that failed to dissolve was separated by filtration and the clear solution was dialyzed until free from chlorides. During dialysis the proteid was deposited in spheroids which did not, like amandin, unite to a confluent mass. The precipitated globulin was then filtered out, washed with water, alcohol and absolute alcohol and dried over sulphuric acid. Only 2.87 grams were obtained, equal to about 3.6 per cent. of the meal. This small yield was undoubtedly due to tannin, which rendered the greater part of the proteid insoluble in salt solution.

Dried at 110° this preparation, **6**, had the following composition:

WALNUT GLOBULIN, CORYLIN, **6**.

			Average.
Carbon	50.32	50.32	50.32
Hydrogen	6.63	6.74	6.69
Nitrogen	19.06	19.12	19.09
Sulphur	----	----	23.90
Oxygen	----	----	
			100.00
Ash	0.63		

The part of the ammonium sulphate precipitate which was not taken up by salt solution at 20° was treated with brine at 60°. In this it dissolved almost completely and did not precipitate on cooling. The clear filtered solution was dialyzed free from chlorides, and by the usual process, 2.82 grams or 3.5 per cent. of globulin were obtained, having the following composition:

WALNUT GLOBULIN, CORYLIN, **7**.

Carbon	50.83	
Hydrogen	6.79	
Nitrogen	19.05	19.04
Sulphur	0.89	
Oxygen	22.44	
	100.00	
Ash	0.15	

In order to avoid the presence of tannin, another lot of walnut seeds were drenched for a moment with hot water, whereupon

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the skins were easily stripped off. The crushed meats were then treated with ether to extract the oil and, after removal of ether by exposure to the air, the coarse meal was finely ground and fifty grams were extracted with fifteen hundred cubic centimeters of ten per cent. brine of common salt. The extract was filtered clear, saturated with ammonium sulphate, the resulting precipitate dissolved in salt solution at 40° and the extract dialyzed free from chlorides. The precipitated globulin was then filtered out and treated in the usual manner, giving preparation 8, weighing 10 grams, equal to 20 per cent. of the meal, and having the following composition:

WALNUT GLOBULIN, CORYLIN, 8.

			Average.
Carbon	50.77	50.74	50.76
Hydrogen	6.94	6.83	6.89
Nitrogen	19.10	19.02	19.06
Sulphur	----	----	} 23.29
Oxygen	----	----	
			100.00
Ash	0.32		

Hazel-nut or Filbert, Corylus tubulosa.

Ritthausen (Jour. f. prakt. Chem., 24, 257) has detailed the results of his examination of the proteid of this seed and concluded it to be identical with the conglutin which he obtained from almonds.

In order to satisfy ourselves respecting this substance a quantity of hazel-nut meats was freed from skins and oil as already described in case of walnuts, and finely pulverized. The meal was then extracted with ten per cent. sodium chloride brine and the filtered extract saturated with ammonium sulphate. The precipitated proteid was filtered out, dissolved in salt solution, and the liquid, after filtering clear, was dialyzed free from chlorides.

During dialysis the globulin separated in spheroids which, like those of walnut globulin, settled down, without adhering together to a plastic mass, after the manner of amandin. The precipitated globulin was filtered out and treated in the usual way. When dried at 110° this preparation had the following composition:

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CORYLIN, FILBERT GLOBULIN, 9.

			Average.
Carbon	50.64	50.80	50.72
Hydrogen	lost	6.86	6.86
Nitrogen	19.14	19.19	19.17
Sulphur	0.83	....	0.83
Oxygen	....	....	22.42
			100.00
Ash	0.28		

In properties this preparation exactly resembled the globulin obtained from the walnut. That the two are identical in composition is shown by the following statement:

CORYLIN.

	Walnuts			Filberts.
	6	7	8	9
Carbon	50.32	50.83	50.76	50.72
Hydrogen	6.69	6.79	6.89	6.86
Nitrogen	19.09	19.05	19.06	19.17
Sulphur	23.90	0.89	23.29	0.83
Oxygen		22.44		22.42
	100.00	100.00	100.00	100.00

The properties of this proteid, after drying over sulphuric acid, as exhibited by preparations 8 and 9, are as follows. In the dry state it forms a heavy snow-white powder which, unlike amandin, is entirely insoluble in distilled water at 20° or at 40°. In ten per cent. sodium chloride solution it dissolves readily and completely, as also in exceedingly dilute acids and alkalies. Sulphuric acid, however, dissolves it much less readily than acetic, hydrochloric or nitric acid.

The solution in ten per cent. sodium chloride brine, containing ten per cent. of this globulin, gives an abundant precipitate when diluted with an equal volume of water. More dilute solutions give precipitates on sufficient dilution. Corylin is very much more readily precipitated by dilution than amandin. Hydrochloric acid and acetic acid each gives a precipitate insoluble in considerable excess of acid, when added to saline solutions of the proteid. With mercuric chloride, picric acid, or tannic acid dissolved in ten per cent. sodium chloride brine, heavy precipitates are produced. Saturation with sodium chloride gives a slight precipitate. Saturation with magnesium sulphate produces

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a considerable though partial precipitation. Saturation with sodium sulphate or ammonium sulphate effects a complete precipitation.

Dissolved in a little acetic acid, a precipitate is produced by sufficient nitric acid, which dissolves on heating and partly reprecipitates on cooling. The solution in acetic acid gives a precipitate with ferrocyanide of potassium, but slightly soluble in a large excess of the latter.

With the biuret test the usual violet color is obtained. With Millon's and the xanthoproteic tests the ordinary proteid reactions appear. Dissolved in concentrated hydrochloric acid and boiled, a violet blue color develops on standing.

With glacial acetic acid and concentrated sulphuric acid, solutions of corylin give a violet color. When five per cent. of this proteid is dissolved in ten per cent. sodium chloride brine and the solution heated, turbidity ensues at about 80° and flocks form in small amount at 99°. On boiling the solution, a little more coagulates, but the corylin is precipitated by heat very slowly and incompletely.

When dissolved in dilute potash water and precipitated by neutralization, the proteid dissolves completely in ten per cent. salt solution. These reactions and the results of analysis show this body to be entirely distinct from either amandin or edestin. We therefore propose the name *Corylin*, from the generic name of the filbert, *Corylus tubulosa*, in which this proteid was first found by Dumas and Cahours (Jour. f. prakt. Chem., 28, 398).

Brazil-nut, Bertholletia excelsa.

Weyl (Zeitschr. f. physiol. Chem., 1, 85) described the globulin of the Brazil-nut under the name of vegetable vitellin, and first determined its composition with a close approach to accuracy.

One of us has already investigated this substance as to its composition and properties, when prepared both in the form of spheroids and as perfectly distinct crystals (Osborne, Am. Chem. Jour., 14, 662). This proteid, being evidently different from all others hitherto examined, deserves a distinct name, and we accordingly propose to designate it *Excelsin*.

Oat-kernel.

From the oat-kernel one of us (Osborne, Reports of this Station 1890 and 1891, and Am. Chem. Jour., 14, 212 and 682) obtained

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a crystallized globulin very similar in composition to excelsin, but different in its reactions as well as in crystalline form. This globulin might be classed as a vitellin, and for that reason is here referred to. As yet this proteid has received no specific name and we now propose to call it *Avenalin.*

Hemp, Cannabis sativa; Squash, Cucurbita maxima, and Castor Bean, Ricinus communis.

Proteid preparations from the seeds of hemp, squash and castor bean have been described under the names of conglutin and vitellin. One of us (Osborne, Am. Chem. Jour., 14, 671–689) has shown that these seeds contain, as their chief and characteristic proteid, one and the same substance and has named it *Edestin.* This has been found in a larger number of seeds than any proteid yet discovered, and is the body most commonly called vegetable vitellin. It is readily obtained pure in octahedral crystals, from several seeds, and owing to this fact has been employed in physiological investigations. That it is a different substance from the proteids already described in this article appears to have been mostly overlooked. The properties and composition of edestin are detailed in the paper above mentioned, and in the Annual Reports of this Station for 1893, pp. 179, 214, 216, and 1894, pp. 155, 170, 190.

Coconut, Cocos nucifera.

The proteid of the coconut was examined by Ritthausen (Pflüger's Archiv., 21, 96), who, without identifying it with conglutin, assigned to it a similar composition. Chittenden (Medical Record, 45, 450, and Digestive Proteolysis, New Haven, 1895, p. 32), under the general name phytovitellin, gives the composition of this proteid in close accord with that of edestin, and as he obtained it partly crystallized in octahedra it probably is edestin.

Lupin, Lupinus.

The principal proteid contained in lupin seeds is the body to which Ritthausen first gave the name conglutin (Eiweisskörper, Bonn, 1872, and Jour. f. prakt. Chem., 25, 422). We have devoted much labor to the study of this proteid, but the results of our work are not yet complete and will form the subject of a future paper. We find that it is distinctly different in composi-

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tion and properties from the proteids which we have hitherto noticed, and we take especial pleasure in confirming to it the name *Conglutin* proposed by its veteran discoverer.

We give on page 301 the composition of conglutin as found by us in accordant analyses of six preparations from the blue lupin.

Sunflower, Helianthus.

The proteid of the sunflower seed as described by Ritthausen (Pflüger's Archiv., 21, 81) appears to be identical with edestin, but our investigation of this substance, which is still in progress, shows that the proteid prepared by the usual methods is contaminated with the helianthotannic acid described by Ludwig and Kromayer (N. Br. Arch., 99, 1 and 285). As yet we have been unable to obtain this proteid in the pure state.

To the best of our knowledge the proteids noticed in this paper include all which have been hitherto designated either as conglutin or vitellin. Of late years many seeds have been described as containing vitellin, but its presence has been inferred from qualitative reactions and not, except in those cases mentioned in this paper, from a study of the isolated proteid.

We have accordingly at least six perfectly distinct proteids which have been confounded together under the name vitellin or conglutin. The following table shows the present state of our knowledge concerning the composition of these globulins and sets forth the characters in which they have been found to differ.

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Proteids formerly known as Vitellin or Conglutin.

	Edestin.	Amandin.	Corylin.	Excelsin.	Avenalin.	Conglutin.
Carbon	51.65	51.30	50.72	52.18	52.18	51.00
Hydrogen	6.89	6.90	6.86	6.92	7.05	6 90
Nitrogen	18.75	19.32	19.17	18.30	17 90	17.99
Sulphur	0.85	0.44	0.83	1.06	0.53	0.40
Oxygen	21.86	22.04	22.42	21.54	22.34	23.71
	100.00	100.00	100.00	100.00	100.00	100.00
Salt solution saturated with—						
Sodium chloride.	No pp.	No pp.	No pp.	No pp.	Complete pp.	No pp.
Magnesium sulphate.	Complete pp.	Partial pp.	Partial pp.	Slight pp.	Complete pp.	No pp.
$HgCl_2$.	Pp.	No pp.	Pp.	No pp.	Pp.	No pp.
Solution of 10% proteid and 10% sodium chloride diluted with equal volume of water gives—	Pp.	No pp.	Pp.	Slight pp.	Pp.	No pp.
Heat coagulation—						
Turbidity.	88°	75°	80°	70°	No coagulation even on boiling.	Trace of coagulation at 99°, sets to jelly on cooling.
Flocks.	95°	80°	99°	84°		
Precipitate by dialysis,	Octahedral crystals or spheroids, pulverulent.	Spheroids, uniting to viscid semi-fluid.	Spheroids, pulverulent.	Hexagonal plates or spheroids, pulverulent.	Spheroids, pulverulent.	Spheroids uniting to plastic mass.
Found in seeds of—	Hemp, Castor bean, Squash, Flax, Cotton, Wheat, Rye, Barley, Maize, Coconut.	Almond, Peach.	Walnut, Filbert.	Brazil-nut.	Oat.	Lupin.

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RECENT LEGISLATION AFFECTING THE STATION.

In the Report of the Board of Control, page xv, mention is made of Acts affecting this Station, passed by the General Assembly at the January session, 1895.

The text of these Acts is here printed in full.

It was intended to print in this Report an account of work done under the Food Act during the last quarter of the State fiscal year of 1895, but various causes have rendered it impracticable to do so, and with consent of the Governor this account will be printed in the next Report and at an early date.

[Substitute for House Bill No. 16.]

An Act making an Appropriation to the Connecticut Agricultural Experiment Station.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. The further sum of two thousand dollars annually is hereby appropriated to the Connecticut Agricultural Experiment Station, to be paid in the same manner as now provided by section 1714 of the general statutes; and the treasurer of the board of control of said station, before any of the money hereby appropriated is paid, shall give an additional bond in the sum of four thousand dollars, and hereafter on any subsequent appointment such treasurer shall give bond with surety to the State of Connecticut in the sum of fourteen thousand dollars, for the faithful discharge of his duties as such treasurer.

SEC. 2. The sum of two thousand five hundred dollars is hereby appropriated to the Connecticut Agricultural Experiment Station for the purpose of better equipping, and making additions to, the chemical and botanical laboratories of said station, for building and equipping vegetation houses on the land of said station, to be used for the purposes of said station, and to aid in experiments in the fermentation and cure of tobacco on the land of the Connecticut Tobacco Experiment Company in the town of Windsor; the said sum to be paid only on vouchers approved by the director or vice-director of said station, and filed with the comptroller, who is hereby directed to draw his order for the payment of the same.

SEC. 3. This act shall take effect from its passage.

Approved, June 26, 1895.

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[Senate Bill No. 167.]

CHAPTER CCXXXV.

An Act regulating the Manufacture and Sale of Food Products.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Manufacture or sale of misbranded or adulterated food.

SECTION 1. It shall be unlawful for any person, persons, or corporation within this state to manufacture for sale, offer, or expose for sale, have in his or their possession for sale, or to sell, any article of food which is adulterated or misbranded within the meaning of this act.

Term food defined. Term misbranded defined.

SEC. 2. The term food, as used in this act, shall include every article used for food or drink by man, horses, or cattle. The term misbranded, as used in this act, shall include every article of food and every article which enters into the composition of food, the package or label of which shall bear any statement purporting to name any ingredient or substance as not being contained in such article, which statement shall be untrue in any particular; or any statement purporting to name the substance or substances of which such article is made, which statement shall not give fully the names of all substances contained in such article in any measurable quantity.

When an article shall be deemed to be adulterated.

SEC. 3. For the purposes of this act, an article shall be deemed adulterated: First, if any substance or substances be mixed or packed with it so as to reduce or lower or injuriously affect its quality or strength; second, if any inferior substance or substances be substituted wholly or in part for the article; third, if any valuable constituent of the article has been wholly or in part abstracted; fourth, if it be an imitation of or sold under the name of another article; fifth, if it is colored, coated, polished, or powdered whereby damage is concealed, or if it is made to appear better or of greater value than it is; sixth, if it contains poisonous ingredients which may render such article injurious to the health of a party consuming it, or if it contain any antiseptic or preservative not evident and not known to the purchaser or consumer; seventh, if it consists, in whole or in part, of a diseased, filthy, decomposed, or putrid substance, either animal or vegetable, unfit for food, whether manufactured or not, or if it is in any part the product of a diseased animal, or of any animal that has died otherwise than by slaughter; *provided*, that an article

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of food product shall not be deemed adulterated or misbranded within the meaning of this act in the following cases: (*a*) In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food under their own distinctive names, and not included in definition fourth of this section; (*b*) in the case of articles labeled, branded, or tagged, so as plainly and correctly to show that they are mixtures, compounds, combinations, or blends; (*c*) when any matter or ingredient is added to a food because the same is required for the protection or preparation thereof as an article of commerce in a fit state for carriage or consumption, and not fraudulently to increase the bulk, weight, or measure of the food or to conceal the inferior quality thereof; (*d*) when a food is unavoidably mixed with some extraneous matter in the process of collection or preparation.

Connecticut Agricultural Experiment Station to make analyses.

SEC. 4. The Connecticut Agricultural Experiment Station shall make analyses of food products on sale in Connecticut suspected of being adulterated, at such times and places and to such extent as it may determine, and may appoint such agent or agents as it deems necessary; who shall have free access, at all reasonable hours, for the purpose of examining, into any place wherein it is suspected any article of food adulterated with any deleterious or foreign ingredient or ingredients exists, and such agent or agents upon tendering the market price of said article may take from any person, firm, or corporation samples of any article suspected of being adulterated as aforesaid, and the said station may adopt or fix standards of purity, quality, or strength when such standards are not specified or fixed by statute.

Notice to prosecuting officers.

SEC. 5. Whenever said station shall find by its analysis that adulterated food products have been on sale in the state, it shall forthwith transmit the facts so found to a grand juror or prosecuting attorney of the town in which said adulterated food product was found.

Report.

SEC. 6. The said station shall make an annual report to the governor upon adulterated food products, in addition to the reports required by law, which shall not exceed one hundred and fifty pages, and said report may be included in the report which said station is already authorized by law to make, and such annual reports shall be submitted to the general assembly at its regular session.

Appropriation.

SEC. 7. To carry out the provisions of this act, the additional

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sum of twenty-five hundred dollars is hereby annually appropriated to said Connecticut Agricultural Experiment Station, which sum shall be paid in equal quarterly installments to the treasurer of the board of control of said station, upon the order of the comptroller, who is hereby directed to draw his order for the same.

Penalty.

SEC. 8. Any person who, either by himself, his agent, or attorney, with the intent that the same may be sold as unadulterated, adulterates any food products for man, or horses, or cattle, or knowing that the same has been adulterated, offers for sale or sells the same as unadulterated, or without disclosing or informing the purchaser that the same has been adulterated, shall be fined not more than five hundred dollars, or imprisoned not more than one year.

Action not to be maintained on illegal sale.

SEC. 9. No action shall be maintained in any court in this state on account of any sale or other contract made in violation of this act.

SEC. 10. All acts and parts of acts inconsistent herewith are hereby repealed.

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